SEPTIC OSTEOMYELITIS OF THE BONES
OF THE SKULL AND FACE*

A PLEA FOR CONSERVATIVE TREATMENT†

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In this paper it is proposed to consider only inflammation or death of bone due to infection with a pus-producing organism, but three somewhat distinct clinical entities will be included.

1. The condition commonly called "ulcerated tooth."

2. Frank ostitis and necrosis of the dentigerous bones.

3. The spreading ostitis and necrosis that may accompany or follow pus infection of the para-nasal or para-aural sinuses.

Our reasons for including these in one group are:

1. They are each essentially a bone infection, and though showing certain individualizing characteristics, the pathology is basically the same, the reaction differing rather in degree than kind, and we believe the treatment of each is essentially the same. 2. Further, while the lines that demarcate the typical cases in each group can be sharply drawn, there occur apparently borderline cases that are not so easily catalogued, and the close anatomical relation of the parts affected facilitates this grouping.

General Conservatism in Treatment of Pus-infected Bones.—There is an Italian proverb which says, " He who goes slowly goes safely; he who goes safely goes surely."

The above can be taken as a safe guiding text in the treatment of simple osteomyelitis of at least the jawbones. The general plan of good surgical treatment of simple purulent osteomyelitis was firmly established many years ago, and, except as influenced by the presence of the teeth, its treatment when affecting the skull and jaws differs little from that of any other bone. Due partly to the superior resistance of the face and mouth tissues to most infections, and partly to the readiness with which spontaneous drainage is estab-

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lished around the teeth, in the jaw the disease has not the inherent fatal tendency that may characterize it elsewhere. On the other hand, the deformities that result, most commonly from ill-advised surgery, can be little short of ghastly. In certain spreading infections of calvarium this is not true. Resulting deformities are not marked, but disease is frequently fatal.

The accepted treatment of osteomyelitis in general, as handed down to the senior collaborator some thirty odd years ago, consisted in, first, the early establishment of drainage of the focus with the least possible operative trauma; second, waiting until the virulence of the infection had subsided, the dead bone had spontaneously separated and sufficient new bone had been formed to maintain continuity before attempting any radical operation; third, at the proper time to remove all fragments of dead bone with limited damage to granulations lining their beds, and, where practicable, to remove all edges

a   b

FIG. 1.—Case III.

of live bone that overhang bed so that soft tissue can drop into and fill these defects. The latter can often be facilitated by fashioning appropriate and well-nourished flaps of skin and subcutaneous tissue; muscle may be included.

When the above program is faithfully and intelligently carried out the disease will seldom prove fatal or progressive, and successful sequestrectomy followed by permanent healing will usually be accomplished by one operation. When dealing with cavities in cancellous bone near joints the propriety of the latter part of the procedure may be questioned by some surgeons who are accustomed to filling such defects with Mostig's bonewax, gauze, or some other substance, but there are comparatively few instances where a live flap cannot be advantageously substituted for these foreign fillers.

Many advantageous refinements of technic have been more recently worked out. Especially desirable are those that strive to raise the resistance of the tissues or to protect the granulation lined cavities from secondary infection, or to sterilize them by non-corrosive lotions, but any radical departure from the basic principles just cited is apt to be followed by disaster or embarrassment in one form or another. This older plan of conservative treatment has in late years been subjected to very forceful attacks, first by the operating dentists and exodontists, later by the rhinologists. The following will be an attempted recapitulation of the facts as we have observed them:

Portals of Entry.—If we are to consider prophylaxis against spreading septic infections within the jawbones, we must go into the etiology at least as far as portals of entry.

In the upper jaw the infection may apparently be by way of the nasal mucosa or antrum. (See Case Reports I and II.) In either jaw it can unquestionably be blood carried from a distance, as is common in osteomyelitis in other bones, but where infected teeth are present, it may be difficult to draw absolute conclusions. Commonly in children the necrosis apparently follows the extraction of a tooth, but in at least some of these the bone infection may have caused the symptoms for which the tooth was drawn. When the symptoms are first noted immediately after the treatment of a quiescent non-vital tooth, this rather suggests a pre-existing periapical infection which may have been present for years. When such an infection involves a tooth with intact walls, it must be considered as being of blood-borne origin. In one child the necrosis followed an extraction during the acute stage of a fulminating infection,

FIG. 2.—Case III.

and we have had such a history in a few adult cases, but it has been our observation that trouble following extractions under such conditions is more apt to result in diffuse infection of the soft parts and occasionally the death of the patient rather than an extensive necrosis of the bone.

While it is not safe to reach a *post hoc ergo propter hoc* conclusion in every, or even the majority of cases, it is, nevertheless, all things considered, a safe clinical bet that prevention of decay and of injury to the teeth will prevent possibly quite a large percentage of these bone infections.

There may occur a low-grade bone infection that forms little pus, more or less pain, and a variable amount of swelling. It is apt to attack different parts of the same jaw or both jaws simultaneously or consecutively, throwing

off a sliver of bone here or loosening a tooth there, going on for a long time without coming to any definite conclusion or without showing any very definite head for surgical attack. The patient meanwhile may show various signs of intoxication.

In the earlier literature the belief that this type of necrosis was dependent on syphilis is quite common, but such an etiological factor now appears to be rather rare. The former belief was, in the past, quite firmly held by the senior writer of this paper. We find but few of the Wassermann reports of these cases to be positive, and it may be that the apparently good results from anti-syphilitic t h e r a p y were due either to some antiseptic quality in the medication or to the delay entailed which gave further time for the development of s p e c i f i c antibodies.

In the bones of the calvarium the para-nasal sinuses are most commonly the p o r t a l s o f entry.

T h e "U l c e r a t e d T o o t h."—T h e above t e r m commonly designates an acute exacerbation of a p r e v i o u s l y quiescent peri-apical infection; t h i s naturally and by common consent will call for the ministration of the dental sur-

FIG. 3.—Case IV.

geon. The attack may terminate or be terminated in one of several ways. After two days of suffering an abscess may perforate the bone, causing the typical " gum boil " or less commonly it may burrow out alongside of the root of the tooth. The dentist may get drainage through a root canal, or an attempt may be made to abort the process by extracting the tooth. The latter treatment has the virtue of precluding future attacks and may be followed by quick recovery, by a more or less protracted or stormy convalescence, or occasionally by death from general sepsis.

It was an old teaching in dentistry that these teeth should not be pulled during the period of acute swelling, and there is usually sound clinical observation back of these older teachings. With more modern and antiseptic technic, the general trend is to substitute active intervention for cultured conservatism and above all with the advent of the " exodontic " specialist, this

older teaching lost precedence. The attempt to establish free drainage and at the same time remove the supposed focus is apt to appeal more strongly to the new dentist. This procedure has been compared to the removal of an acutely diseased appendix, but the simile is inapt because the appendix is the focus of the infection, while the tooth is at this time but an inert plug. In their results the two procedures do not parallel and the observer standing on the side line, who takes occasion to sort over the wreckage, is apt to conclude that the average results do not justify the extra risk inherent to early extraction. In a certain small percentage of cases the reaction is accompanied by an increase of symptoms, or is followed by abscess formation, or extensive bone necrosis.

In addition to this some young or apparently robust people will die from general sepsis following extraction of an "ulcerated tooth" in the acute stage. On the other hand, death following the conservative plan is extremely rare, and except among young children, cervical abscess or extensive bone necrosis is uncommon, where the tooth and the bone are spared the trauma of instrumentation in the acute stage of the infection.

This may seem difficult to explain, but a

Fig. 4.—Case V.

study of the history of a typical case will at least furnish food for thought.

The "ulcerated tooth" is a culmination of an infection that has been present for an indefinite time, possibly years, without giving more than mild or unidentified symptoms. Often the root canals of the damaged tooth had long ago been sealed by the dentist, and it is usually difficult to assign any logical cause for the explosion. About the simplest explanation is the assumption that a disturbance of the balance between virulence and resistance has occurred which permits the hitherto imprisoned bacteria to successfully attack the confining barriers. Such a period of low resistance may be the reason why the trauma of an extraction may not be well tolerated at this particular time. This type of acute osteomyelitis should hold more than an academic interest for both the physician and the surgeon, either of whom must occasionally help a patient to choose between the man who offers immediate and permanent relief from a jumping toothache by a painless extraction

under gas, and the old-fashioned dentist who prescribes quinine, phenacetin, the mustard foot bath, the fig poultice, and who may attempt to establish drainage by the somewhat painful process of opening a root canal. The former may be the more brilliant procedure, but we can still give the conservative man our moral support with the assurance that his plan is the safer. Besides, the physician can always add sufficient morphine at least to ease the time of travail, and possible he may shorten it by an incision and a stripping up of the periosteum at the likely site of perforation.

At a later period when the balance between virulence and resistance has been reëstablished in the patient's favor, extraction of the tooth is not only safe, but is better surgery than the most effective dental restoration.

This taboo against immediate extraction applies only to the period of acute local symptoms evidenced chiefly by swelling of the neighboring soft tissues,
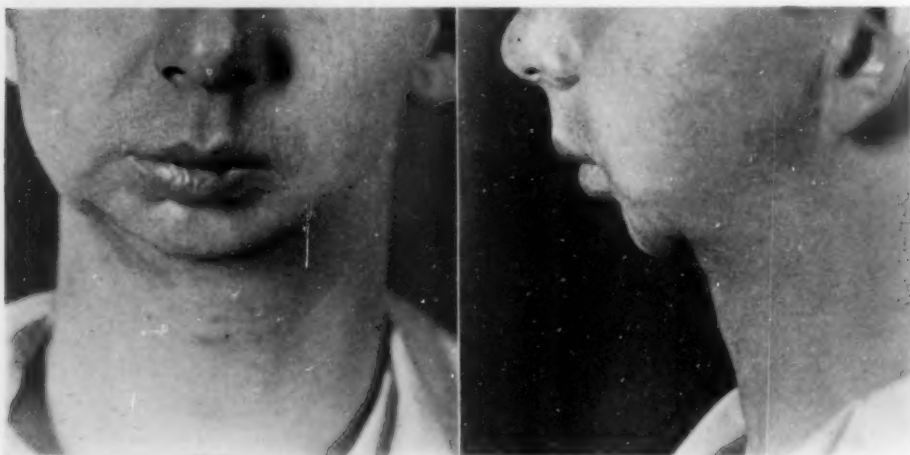
a   b
FIG. 5.—Case VI.

and by the pain and tenderness that are characteristic of early osteomyelitis, not to the subacute stage in which discomfort, low fever, adenitis, malaise, rheumatism or joint infections, etc., may evidence chronic infection. If, however, an extraction under these latter conditions is followed by a severe local flare-up, then there may be good reason to go slow on repeating the insult.

Necrosis of the Jawbones.—Simple osteomyelitis of the upper jaw resembles the same affection in other cancellous bones, in that it is of more rare occurrence and the necrotic areas are apt to be less extensive.

In either jaw the need for early artificial drainage of the focus is seldom urgent, though confined or pocketing collections of pus should be liberated by internal or external incision when detected. It is maintained by many of the dental profession that the application of external heat in the early stages fosters the formation of an external fistula. We have done the thing that has given the patient the greatest comfort, whether it has been the use of heat or cold.

The very objectionable odor that is given off from some older cases of

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jaw necrosis we have found to be controlled by one or two thorough irrigations of all fistulæ with a quantity of 1 per cent. solution of formalin (2½ per cent. solution of the 40 per cent. preparation of formalin) in water. The stinging pain of the injection does not last long, but can be modified by a previous irrigation with 1 per cent. novocain.

It is difficult to set an exact time, but in the ordinary straightforward acute osteomyelitis of the jaw the dead bone will usually have separated itself in ninety days, and by this time a strong involucrum will have formed that will permit the removal of the sequestrum without changing the normal contour of the jaw. It has been our observation that instrumental manipulation of the bone, of at least the lower jaw, before the infection has lost its virulence, is very apt to be followed by further extension of the necrosis. In certain cases in which the periosteum has been stripped off or other
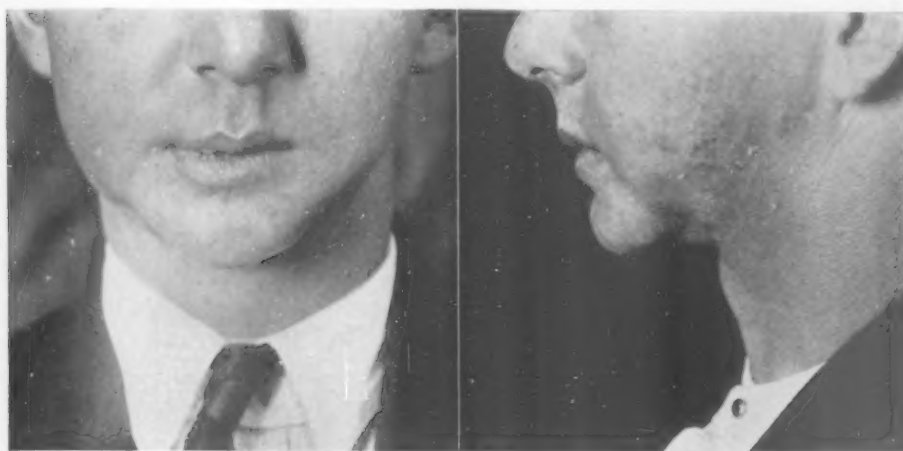

a   b

FIG. 6.—Case VI.

attempts have been made to dislodge a piece of dead bone before it has become loose, we have found different segments in the same jaw that have been dead for different periods of time, so that one piece may be loose, " worm-eaten," and encased in a strong involucrum, while a neighboring piece may have but recently died and not yet detached, or if detached, surrounded by so little new bone formation that after its removal the jaw may collapse at this segment or the bone may fail to regenerate. (See Case III.)

In some cases of extensive necrosis it may be very good surgery to divide the radical operation into several steps, thoroughly cleaning out one area at a time. We have found that the surest way of cutting the necessary number of radical operations to the minimum is to give a full three months between the original infection, or any subsequent instrumentation, before attempting to remove the dead bone, and then, if it is not found to be " worm-eaten " and surrounded by a definite bed of granulations, to wait another three months before making a subsequent attempt.

For other reasons it may be desirable to wait very much longer than

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three months before disturbing dead bone that is in close relation to developing teeth. Up to a very few years ago it was our practice to remove not only all loose " worm-eaten " fragments of bone, but all teeth and tooth buds that were definitely within the necrosed area on the theory that they must be dead and could only act as harbingers of infection. It was Dr. Virgil Loeb of this city who first called our attention to a case of which had a very striking series of X-rays. The first showed certain partially developed teeth to be very definitely surrounded by dead bone. Doctor Loeb had not done a radical operation, but had waited for the dead fragments to be thrown off spontaneously, with the result that the tooth buds continued to develop, and the

FIG. 7a.—Case VII.

slightly deformed teeth had become fixed in the newly developed jawbone as demonstrated by a radiograph. Since then we have verified this result on several of our own patients, and it is now our custom in treating necrosis of the body of the jaw in a child to furnish drainage as indicated, watch closely for kidney damage, and, if the general condition permits, to do no radical operation on the alveolar portion, but wait for the fragments to be thrown off spontaneously.‡ Fortunately, in children in the tooth-bearing areas

the dead bone is not apt to become deeply sequestrated, as may happen in the ramus, but this does not hold true with adults. (See Case IV). The preservation of the tooth buds is of tremendous advantage. In areas where they are completely lost, the new bone is apt to be short to the extent of very serious deformity. (See Cases V and VI.) If one first or second molar is preserved, it may save excessive retraction of the regenerated jaw, but preservation of the third molar bud will not do this. (See Cases VII and VIII and V and VI.)

Much more disastrous than the removal of tooth buds is the complete lack

‡ Cryer quotes Percy, of Paris, in 1791, as having observed that teeth in the necrosed area of bone finally recovered their original solidity and were firmly implanted in the thickened gum. Necrosis following extraction was known as far back as Heister's time (1710), and he warned against extractions in inflammatory affections of the jaws.

of regeneration that may follow the too early removal of the dead bone or the attempt to control infection by resecting the original live bone. (See Cases VI and IX.) We know of one case in which the entire lower jaw is lacking from repeated attempts of this kind, and there never has come under our notice a single instance of failure of regeneration of the mandible following a simple osteomyelitis that had not been subjected to early energetic bone surgery. (See Case IX.)

Plan of Removal of Sequestra.—In the lower jaw the incision is made along the alveolar process; or (as was necessary in Case IV), an incision can be made on the skin surface along the lower border of the mandible and part way up the posterior border of the ramus from one side to the other. For necrosis of the ramus in adults, for locating dislodged spicules in the sigmoid notch, the posterior part of the incision just described is most appropriate.

After the sequestrum has been exposed, slip a curette under the various fragments and ease them out, the cutting edge turned toward the dead bone and not toward the involucrum. This plan is usually sufficient, even for a totally necrosed ramus and condyle. When the sequestrum is buried in hard bone, it

FIG. 7b.—Case VII.

may be necessary to chisel away one wall of the involucrum before the above can be carried out. Where the pockets are multiple they must be dealt with individually, but all may be cleared out at one operation. A curette makes a most efficient persuader, and it should be used as a tractor, an elevator, or as a tool to carve away overhanging involucrum, but as a bone scraper only when hunting for hidden fistulæ that might lead to other sequestra. Bone scraping as a habit is a pernicious practice, and is to be deplored even when necessary. The search for small deeply buried spicules may be greatly facilitated by a preliminary injection of the fistula with methylene-blue solution.

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In every case every piece of dead bone must be removed or so treated that it can be discharged spontaneously, otherwise, the wound will not heal permanently. It is for the lack of such treatment that many cases remain unhealed for a period of years that otherwise might have been cured in a few months.

In the upper jaw the sequestra are apt to become buried in scar. In seeking to remove these, it is a better plan to dissect out the scar than to try to find the individual pieces of bone. This is sometimes true in regard to fragments in the neck that have worked down from the lower jaw. (See Case X.)

Fig. 7c.—Case VII.

In all the preceding the emphasis has been on time-consuming conservatism, but when conditions become right for r a d i c a l operation, one should act boldly and efficiently. The necrosed alveolar process will be thrown off spontaneously or with very little help, but pieces of dead bone in the body or ramus will become encased by the living b o n e unless surgically removed and can remain indefinitely as a f o c u s of infection. (See Cases XIII, XIV, and XV.) If, after the sequestrum has been removed, the pocket in the involucrum is very deep, surrounded possibly by overhanging walls, such a cavity may take years to scar over, and, therefore, should not be left in this condition.

Conservatism the Most General Choice.—The literature still shows the old division between those who advocate early conservatism versus those who promise to abort the disease by the earliest possible radical surgery. The position of the latter, who are still in the minority, is supported by neither new arguments nor any adequate number of convincing case reports.

CASE REPORTS ¶

Cases considered in this paper do not include those primarily due to open injury to the bone; this rules out all open fractures.

¶ The "follow-up" of these cases has been made possible only by the coöperation and work of the Social Service Department.

The case reports are taken from cases treated since 1916 at Barnes Hospital, St. Louis Children's Hospital and St. Louis Mullanphy Hospital, because since that time the plan of recording histories has been more uniform.

CASE I.—Girl, two and a half years. Infection of maxilla, occurring most likely through antrum during course of diphtheria, treated expectantly, followed by recovery.

During course of diphtheria swelling of right side of face occurred with, later, a discharge of pus. Removal of loose pieces of bone from outer surface of maxilla five, six, and seven months later, with entire recovery.

FIG. 8.—Case VII.

CASE II.—Baby, six and a half months. Infection of maxilla and orbit probably of antral origin. Early bony extension, bony incision for drainage—death from pneumonia.

Well-nourished baby developed severe general symptoms of an infection and a swelling of the upper gum and hard palate, which later extended to face and orbit. Seven days later, in an effort (probably ill-advised) to obtain drainage, entrance was

FIG. 9.—Case IX.

made through the palate into orbit and antrum, removing several infected tooth buds. Nine days later the orbit was again entered and more pus obtained, but the child died of pneumonia. This is the only case in the whole series of jaw cases that terminated fatally, and we feel that the child's chances of recovery were not helped by the early bone-cutting operation.

Marx, in 1920, called attention to the ocular lesions consecutive to osteomyelitis of the upper jaw in infants.

Nord, in 1924, again called attention to it, and stated that the correct diagnosis was often missed. He gave as treatment a conservative outlet for pus and waiting for spontaneous separation of the sequestrum, with which plan we are in full accord.

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Case III.—Boy, five years. Necrosis of the mandible which probably antedated tooth extraction, bone-cutting operation followed by a further spread of the necrosis; too early removal of necrosed ramus, followed by failure of regeneration of the ramus; persistent fistula due to retained dead, partially developed crown.

The boy had two molar teeth on left side extracted on account of swelling of the face, and a piece of loose bone was removed from the gum in the clinic three days after the extraction. This suggests that the necrosis had antedated the tooth extraction by some considerable time. Three and a half months later an operation was done that seems to have included raising some periosteum and curetting the involucrum. Eighty days after this last operation, the face had again swelled and a very recently necrosed ramus was removed, showing little destruction at the time of operation. This early removal of the ramus was not followed by regeneration.

Persistence of the fistulæ necessitated two further operations, at one a dead tooth bud was removed from the ramus, and at the other a dead, partially developed crown.

The whole course as viewed in retrospect suggests a case of low-grade bone infection with slow separation of the dead fragments, and that the infection was spread and new areas of necrosis occurred as the result of the attack on the live bone. The premature

a   b

Fig. 10.—Case IX.

removal of the ramus fragment was, in this case, only an incident, but if a failure of regeneration had occurred in the body similar to that in the ramus, it would have been a catastrophe requiring a subsequent bone graft. There is some retraction of the jaw, as a whole, on the affected side as shown in the photographs (Fig. 1 A and B).

Figure 2 is of an X-ray taken June 16, 1925, eight years and seven months after the last operation, and at the age of thirteen years. The unerupted lower third molar is seen to be in proper relation to its opponent above and to the remaining part of the anterior border of the ramus. This would suggest that at least part of the retraction is due to shortening in the regenerated part of the body. It plainly shows the lack of the ramus, and also shows a somewhat deformed third molar bud.

Case IV.—Man, thirty years. Extensive necrosis with multiple sequestra.

First seen three months after original trouble, and found to have widespread necrosis, with between twenty and thirty pieces of sequestrum buried in separate pockets in the involucrum in the body and rami (Fig. 3). The operations were done over a period of time extending from seven and a half months to two and a half years after the onset of symptoms. There was recovery without diminution of the size of the mandibular arch, but all the teeth were lost. This case would tend to show that the long-delayed operation in adults would not save the teeth. However, the jaw is already developed and the saving of the teeth is not as important as it is where their presence is to be counted on to help preserve the length of the developing jaw.

Case V.—Girl, twenty years of age, who had loss of all tooth buds at five years as a result of necrosis. The measurements made at the time of examination showed the body of the lower jaw to correspond to a normal jaw of about five years. We have

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observed other similar cases. A third molar is present, but this has had no effect on the development of the jaw (Fig. 4).

CASE VI.—Man, twenty-two years of age. Failure of regeneration of jaw after curetting operation on lower jaw for necrosis one month after a tooth infection.

Operation for necrosis at eight years of age. First seen at twenty-two years. The third molars were the only teeth that had developed with the resulting lack of development of mandible. (Fig. 5, A and B, showing deformity.)

Figure 6, A and B, after cartilage and skin grafts to permit use of tooth-carrying prosthesis. Prosthesis made by Dr. James A. Brown.

CASE VII.—Girl, ten years. Extensive necrosis of mandible following filling of a tooth. Sequestrectomy delayed eight months, with preservation of some molar teeth that were in the necrosed area, and preservation of almost the normal length of the jawbone.

Two weeks after the filling of a tooth the tissues over mandible swelled, first on right, then both sides; pain, abscess opened, and loose anterior teeth extracted two

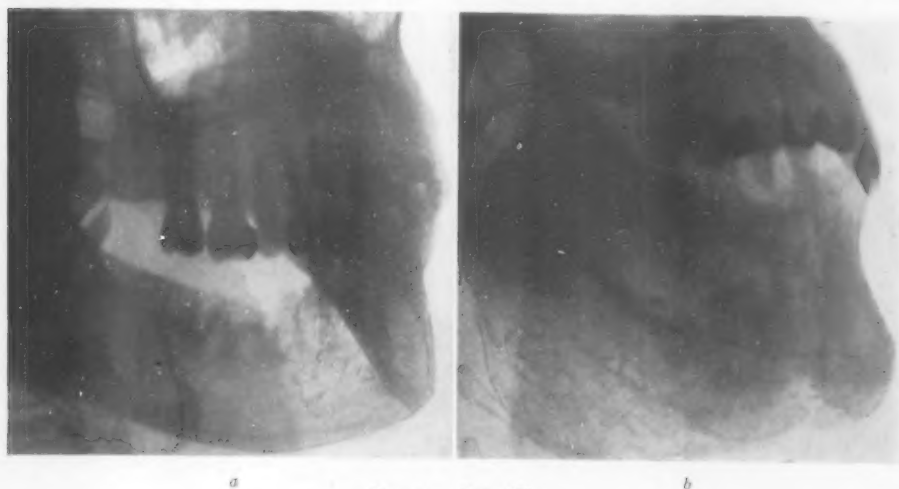a   b

FIG. 11.—Case XI.

months later. Pus continued to drain and was first seen at the Washington University Dispensary two months after first symptoms. X-ray condition at this time is shown in Fig. 7A. It shows complete necrosis of the left side of body and ramus, the necrotic bone breaking into fragments, a fully erupted lower first premolar, and a partially erupted second premolar and second molar. New bone formation of the developing involucrum can be seen on the mental part of the body, but an attempt to remove the sequestra would have resulted in the loss of all associated teeth, and most likely in a failure of development of new bone. Drainage had continued for five months, when the child was sent to the St. Louis Children's Hospital to determine if the continuous suppuration had or was likely to cause kidney or other vital damage. Doctor Marriott advised that he thought it safe to continue without at the present time removing the sequestra.

Figure 7, B, shows a well-developed involucrum, and that the second premolar has either erupted further or is being thrown off. The developing crown of the third molar is also apparent. The masses of the sequestra are more clearly defined. It was in hopes of preserving some of the developing teeth that the sequestra were not removed at this time. The child was kept under careful observation, with repeated blood and urine examinations, three months longer. Eight months after first appearance of the symptoms, Dr. Earl Padgett (then an associate in this service) removed the sequestra and rongeured away overhanging bone. Child made a good recovery and the condition

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of the superficial tissues corresponding to the missing bone, and she had several bad teeth, which were pulled.

Figure 9, A and B. Showing deformity of jaw and lack of soft parts.

Figure 10, A and B. Appearance after skin and rib grafting and with prosthesis in place. Prosthesis made by Dr. James A. Brown.

CASE X.—Boy, eight years. Maxillary necrosis related to tooth infection; repeated early operations failed to control symptoms.

Necrosis of maxilla following tooth extraction. During the next few months there were five operations on the bone in an attempt to control the suppuration. Eight months after the first appearance of symptoms there was a discharging fistula under the outer part of the left lower eyelid in a scar attached to the infraorbital border. This scar mass was dissected out without identifying the sequestra and drainage established into upper fornix of the vestibule of the mouth. No bone fragments were found; skin incision closed with small drain in place. Child recovered with one mild return of

a   b
FIG. 13.—Case XV.

symptoms about three months later. Report by letter eleven months later states child is well.

CASE XI.—Woman, forty-eight years. Antisyphilitic therapy and sequestrectomy after two years.

Gland enlargement under jaw; tooth pulled, followed by persistent purulent discharge. Wassermann negative; only suggestion of syphilis the ostitis and two miscarriages without further pregnancies. Blood-pressure over 200. Antisyphilitic treatment was given. Two years later partial sequestrectomy done. Six months after this there was still X-ray evidence of dead bone, but there had been so much improvement that waiting longer was advised. Patient died that same month—apoplexy.

Figure 11, A and B. X-rays taken seven months apart show a progressive bone involvement.

CASE XII.—Man, forty-eight years. Wassermann negative, but some relief of symptoms of pain and infection by salvarsan therapy. Sequestrectomy finally done.

Nineteen hundred and nineteen: Soreness and tenderness in all molars and they loosened. Nineteen hundred and twenty-one: Molars pulled, three at a time, and later that year fourteen more teeth pulled at one time. Pain and discomfort continued, and in February, 1922, it became very severe, and thick yellow pus drained into the mouth. March, 1922, X-ray showed "moth-eaten" areas in all molar regions, most marked on right. The remaining teeth were loose and rough bone could be felt in the lower
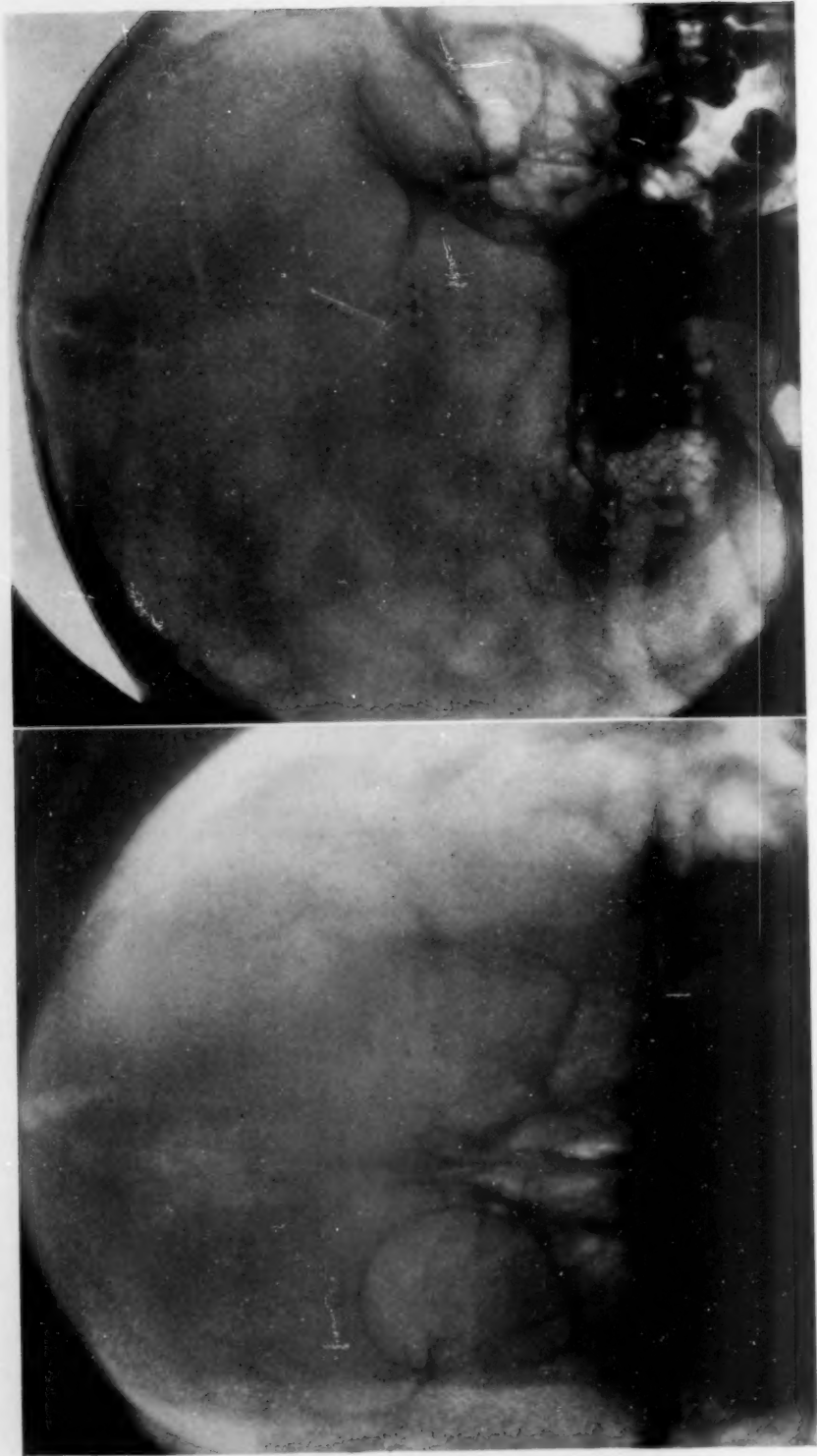
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FIG. 14.—Case I4. Shows moderate sized area of necrosis extending nearly to the vertex.

jaw. Pain was a severe symptom throughout the course of the disease. Diagnosis of necrosis was made with question of syphilis. Several Wassermann tests were negative, but in November, 1922, there was reported marked improvement after antisyphilitic treatment of several months. A clean easy sequestrectomy was done several months later.

Case XIII.—Colored man, twenty-five years. In 1909, at age of nine years, tooth broken in extraction, followed by pain and swelling. There was one operation one year later. He was treated for syphilis in 1924. First seen June 6, 1925. Left jaw swollen, poor occlusion, two sinuses present under jaw, and opening limited. Incision made in front of ear, all tissues turned down, including parotid. Dug out several pieces of dead bone, an impacted molar, and then the condyle and coronoid to give movement. The mouth was still bound with a scar which was cut through.

Case XIV.—Woman, thirty-two years. Multiple extensive involvement of lower jaw with general symptoms that were not relieved until the last piece of dead bone was removed.

She was in perfect health until dental trouble arose after some arsenic had been left in a tooth for two weeks. There was local abscess and many teeth became loose. Widespread necrosis (Fig. 12, A) followed, many teeth were extracted, external drainage was done, and several sequestrectomies. There was local neuralgia, for which two nerve injections were done. There was also rheumatism, which cleared up, and there was a good general recovery after the last piece of dead bone was removed (Fig. 12, B).

Case XV.—Woman, thirty-four years. Following an inlay filling of right lower first molar, pain continued, and tooth was removed with excess trauma one month later. Pain and swelling for months, many small pieces of bone were removed, and jaws locked for months after removal of teeth on that side. Symptoms continued over a year and a half. X-ray shown in Fig. 13, A, taken nineteen months after origin of symptoms, shows a spanner-shaped piece of dead bone lying in the substance of the body and lower part of ramus of the right mandible. The live bone embraces the sequestrum very closely. This, considered with the length of time the symptoms had been present, and the lack of the mention of pus in connection with any of the various manifestations, rather suggests an infection with an organism that is not prone to cause suppuration. Most likely a streptococcus of low virulence.

Through an incision along the lower part of the border of the ramus and lower border of body the tissues superficial to the bone were raised and a sub-cortical sequestrum was laid bare and removed with a chisel. All granulation containing tunnels was converted into shallow grooves, and the soft tissues were sutured back into place with rubber dam drainage.

Patient discharged from hospital four days later, and at no time from then until the second operation was she entirely free from pain, swelling, slight fever, or discharge, though the wound had been re-opened, packed, and wet dressings maintained. An X-ray taken three and a half months after the first operation (Fig. 13, B) shows the channel from which the sequestrum had previously been removed, but no further evidence of necrosis or sequestra. Four months after the first operation the whole area was laid bare, revealing the channels filled with granulations, wound packed, and Dakin treatment maintained for some time. The packing was continued for two and a half months, and when the wound had healed the pain and low fever continued. Later, the inferior dental nerve was injected with alcohol which for the time, at least, relieved the pain. No further observation of the case.

Diffuse Osteomyelitis of the Skull of Sinus Origin.—Most of the recent rhinological literature supports very early and radical operative treatment of the necroses of the skull bones that may follow or accompany para-nasal sinus infections, and a powerful array of facts and figures are cited to support this contention. This reversal of the more generally accepted rules for the treatment of osteomyelitis is not supported by our own clinical limited obser-
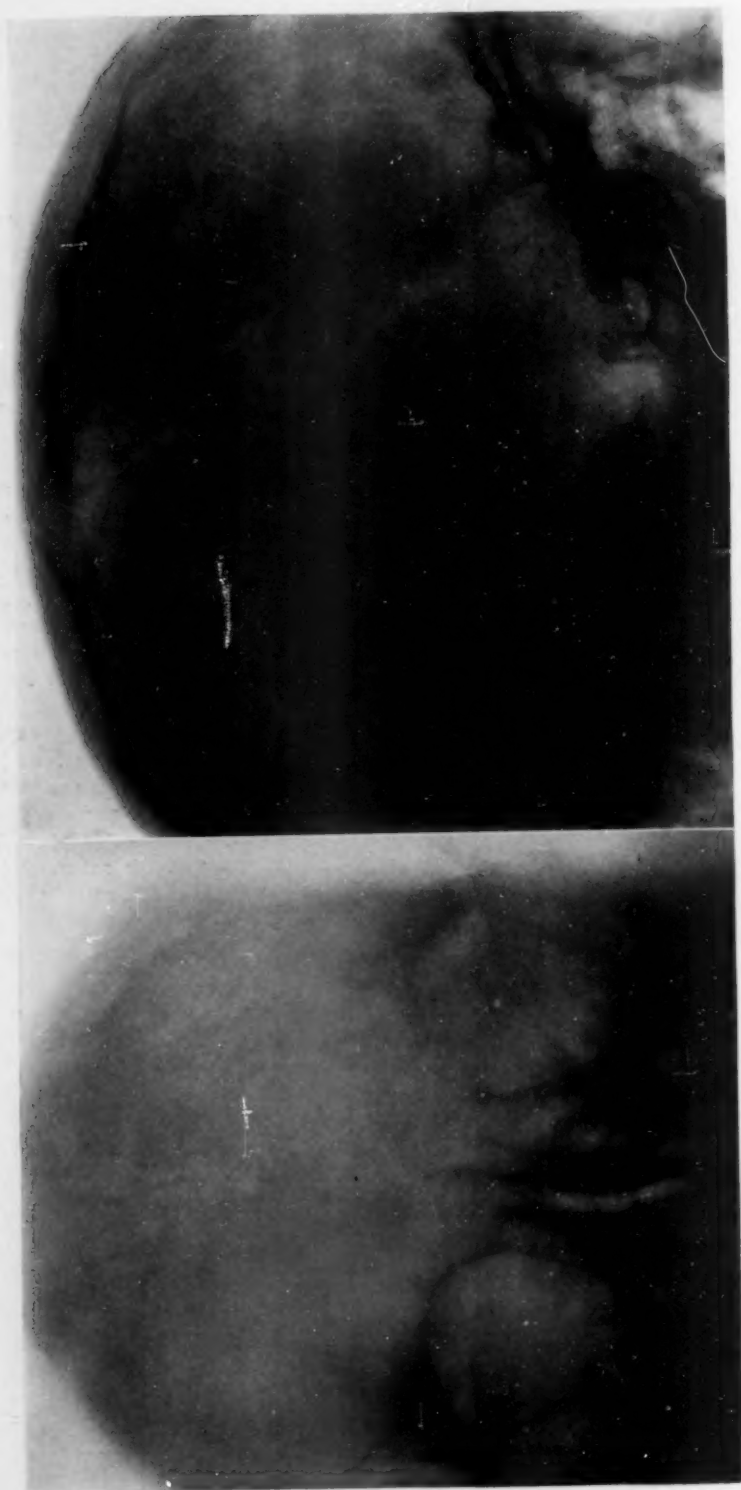
FIG. 15.—Case IIA. Shows extensive rarefaction of frontal bone and some roughening of the parietal region.

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vation of these cases. Therefore, we have dug rather deeply into the literature of the subject reviewing over a hundred articles or detached case reports.

In reference to the literature these seem to be the facts as we have them. The first cases definitely reported as being of sinus origin were in 1899, one by Luc [1] and one by Tilley,[2] but there are a few reports of osteomyelitis of the skull giving practically the same clinical picture, in the literature farther back.[3-8]

The radical writings consist of some twelve to fifteen articles, based partly on personal observations and largely on citations from an exhaustive article, in three parts, by Dan McKenzie, of London, and at the time of the appearance of his articles, 1913, editor of the *Journal of Laryngology, Rhinology and Otology.* The latter writer deduced his conclusions from the study of forty cases that he found in the literature, and from one case of his own. His findings were in the main that the cases (twenty in all) in which the necrosis developed after a sinus operation, died regardless of treatment; that of the

Fig. 16a.—Case IV A.—Shows area of involvement before an attempt was made to cut around it.

twenty-one cases developing spontaneously from sinus infection, seven survived, and all of these seven had been subjected to " appropriate surgical treatment," which, from his article, we are led to believe was early radical bone removal.

This is a rather formidable array of facts against which to argue, and his conclusions, which have had wide acceptance, especially among the rhinologists, are in harmony with his findings.

We have been unable to substantiate all of his findings by referring to the literature.

Four of his cases were definitely described as having had radical treatment. But, in going over the cases, we find that:

One described by Luc was still active after ten months. McKenzie himself, in a discussion of a case report of Mollison's, said that at least six months should be allowed to pass without any symptoms before deciding that the case is cured, and other observers put the period as high as eighteen months.

Downey's recovery case was a chronic one of six years' duration, there was not a very widespread necrosis, and further it was said to have been a syphilitic case.

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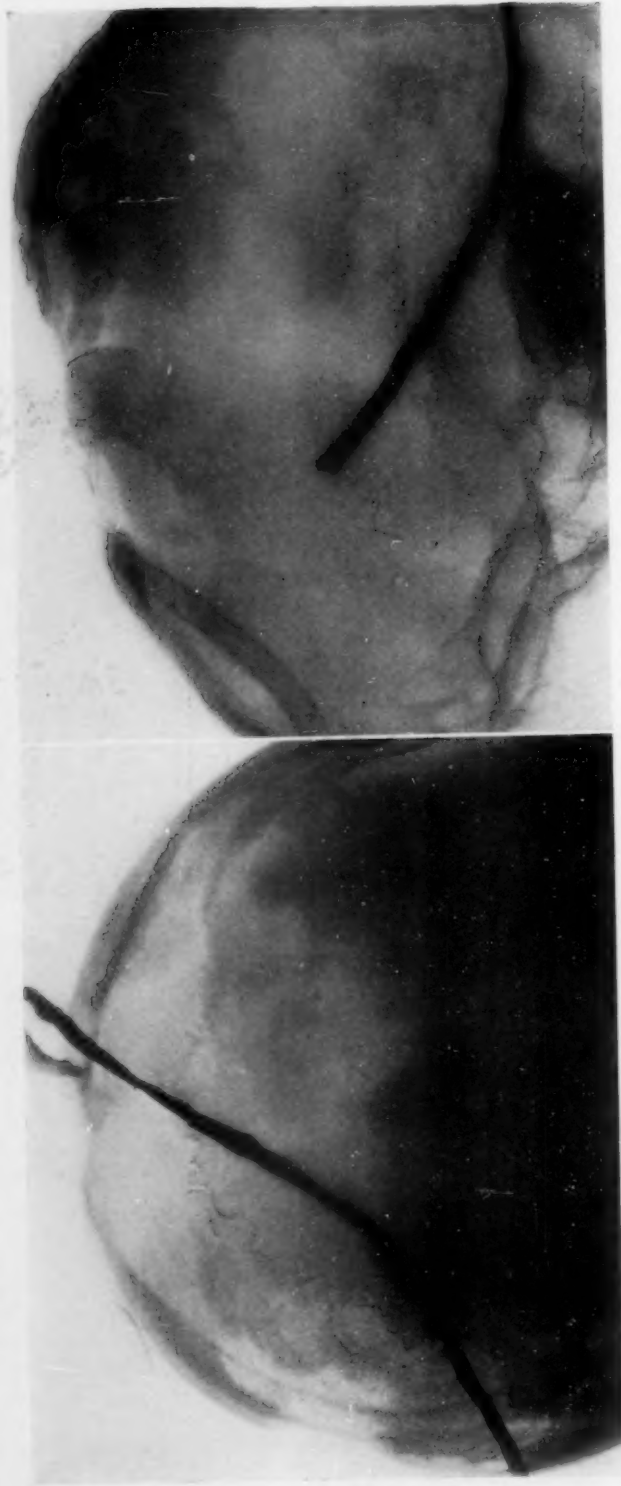
FIG. 16b and c.—Case IVA. Show the wide extension of bone involvement following an attempt to cure the patient by cutting out the diseased bone.

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Syphilitic cases should not be recorded with these cases, as McKenzie himself said in throwing out one reported cured by conservative methods by Spicer.

Davis' case, quoted by McKenzie, seems to have been a post-operative case, and to have recovered with very conservative treatment.

McCoy, 1910, reported a post-operative case that recovered with fairly conservative treatment.

Coffin, 1908, reported a case as cured of the osteomyelitis by operation, but also stated that the patient died. It is not clear to us whether McKenzie reported this as cured or not.

Harrison, 1912, reported a case of mastoid origin as having recovered with very conservative treatment and emphasized the importance of waiting for sequestra to form, of supporting the patient in general, and of using vaccines.

In our study of the literature appearing after these articles of McKenzie's, we found twenty-five cases reported, twelve following sinus operations, twelve arising spontaneously during the course of a sinus infection, and one after trauma.

We have had six cases of this type, five arising from the frontal, and one from the sphenoid sinus. This series we consider rather small upon which to base sweeping conclusions, but of those who have so vigorously advocated early radical treatment no one had more than four cases.

Tilley[2] reported four cases, all treated radically, one lived, and three died.

Kernan[10] reported two cases, one treated conservatively that lived, and one treated radically that died.

Porter[11] reported one case following a sinus operation treated radically that lived for one year and then died of pneumonia. This is said to be the first post-operative case to recover.

Mollison[12] reported one case treated radically that lived, but at the time of the report not enough time had elapsed to be sure of a cure.

McClay[12] had three cases, one living, but no details of the treatment were found; one living following multiple operations over a period of six months or more; one dead two months after a nasal operation without further bone cutting operation.

Skillern[14] reported one case that died after radical treatment, but concluded that radical treatment was delayed too long.

Bryan[15] reported one case, dead after removal of involved bone with curette, and one case living after ten or twelve months.

Milligan and Wrigley[16] gave one very short report of a patient recovering after radical operation.

McArthur[17] reported one fatal case without operation, but concluded that radical treatment was the best. However, he also stated that his case was too far advanced with involvement of bone in the ethmoid region for any treatment to be of avail.

Warren,[18] one case, reported living after bone cutting operation, but reported after only about six months of observation.

Wood[19] reported two cases with death of both, following radical treatment. States that operations were too limited and too long delayed.

Bulson,[20] one case living following reported radical treatment. The operation, however, was two and one-half months after the development of the disease, a time at which the diseased bone might have begun to separate spontaneously.

Eckstein[21] reported a fulminating case that died on the same day of radical operation.

Coffin,[22] as cited in previous footnote.

Turner,[23] one case, died after radical operation, and the author concluded that conservative treatment was best.

Van Den Wildenberg,[24] one case, death following radical treatment.

Von Eicken,[25] two cases, one dead following radical treatment, one dead from brain abscess, without much radical surgery.

Wolff Freudenthal,[20] one case, reported well six weeks after radical treatment.

McKenzie,[9] one case of limited necrosis, bone removed, death.

Patterson,[27] one case living after twelve operations of undetermined nature.

Tod,[28] one mastoid case, dead after radical operation on involved bone.

Knapp,[29] one case, dead after fairly radical surgery.

Thompson,[30] two cases, death of both following operations. Concluded that no kind of operations would stop the process, and mentioned one case that died after eighteen months.

McCoy,[31] two cases, one dead after radical treatment, one living after fairly conservative treatment.

Not all observers report favorably to the radical bone cutting plan of treatment.

Harrison[22] reported the case described in preceding footnote.

Thompson,[30] as recorded here, concluded that the most vigorous treatment would not stop the process.

Le Mere[32] reported a case treated conservatively that died, but his conclusions as to the treatment of choice are not clear to us.

Kernan[10] leans somewhat to the conservative side, at least for chronic cases.

Opdyke[34] reported one post-operative case living after what seems to have been conservative treatment.

Lynah[35] reported one living with conservative treatment, but too soon to be sure of.

Turner[33] turned to the conservative side after losing a case treated radically, and said " once an osteomyelitis of the frontal bone is set up, surgical cure is practically hopeless."

Symonds'[36] case in 1910 appears to have been treated by sequestrectomy.

Mosher, H. P., in a discussion of a paper by Bulson, sounds the same warning of conservatism that is attempted in this paper. He bases his views on observations of a case in which the osteomyelitis progressed after every radical surgical attack, but cleared up entirely under conservative treatment.

In the literature before 1899, at which time cases were first recognized as coming from the sinuses (except the mastoid), there are many reports and discourses on osteomyelitis of the skull bones. After discarding those definitely thought to be tuberculosis or syphilis of bone, some of the others must have been of sinus origin, though unrecognized as such.

Hewitt,[2] in the *Lancet*, 1864, has a long discourse on disease and necrosis of the skull bones, and emphasizes that loosening of the dead bone should be waited for and, except in cases with very limited involvement, radical surgery should never be done. The main object should be to support the patient.

Smith,[4] 1870, reported a case of spontaneous origin and separation.

Gardner,[5] 1865, reported a case with recovery following multiple sequestrectomies over a long period.

Gelston's,[6] 1847, case had full thickness necrosis, and died of meningitis after it was opened.

Hill,[7] 1843, had a long drawn-out case of supposedly traumatic origin that was free of symptoms after a widespread operation twenty-five years after onset.

Marks,[8] 1894, reported a case during conservative treatment, but it was still slightly active at the time of the report.

Of our six cases: 1-A.—One spontaneous frontal sinus case treated by late removal of the exfoliated bone survived and has been well for the past nine years, except for epilepsy, which is not related to the sinus trouble. (Fig. 14.) Patient referred by W. E. Sauer.

2-A.—One frontal sinus post-operative case had twenty-one drainages or removals of exfoliated bone died of thrombosis of an emissary vein after subsidence of all local symptoms and he had been sent home. (Fig. 15.) Patient referred by V. V. Wood.

3-A.—One spontaneous frontal sinus case died of purulent meningitis after conservative treatment for three months by her family physician. Referred by J. M. McClelland.

4-A.—One frontal sinus case treated for eleven months by ten operations (the second one radical, and followed by further spread of the disease) and five blood transfusions. When he became so exhausted that further surgery was not to be considered, he was put on salvarsan (Wassermann negative) and milk injections, and improved so rapidly that he left the hospital in a month and has been working on his farm for the past five years. (Fig. 16, a, b, c.) Referred by W. E. Sauer.

5-A.—One frontal sinus case treated conservatively, had infections in two other parts of the body that may have been metastatic, but at present his head has healed and has been so for about a year. This case is still under observation and is not yet considered cured. Referred by Birsner.

6-A.—One sphenoid case (none others found in the literature, except some of direct perforation of the bone), who died of meningitis with widespread necrosis of the base of the skull. Actinomycosis was found in conjunction with real pus. Referred by G. H. Copher.

While we had but two cases to survive out of five that we were able to follow to a conclusion, we are not yet ready to accept the more modern teaching of early, radical bone removal for these cases, and until more conclusive evidence is adduced, will continue to apply the older rules of hygiene, drainage, and the removal of exfoliated bone. To these we would add an attempt to raise the patient's resistance to an apparently low-grade infection that seems to cause insufficient tissue reaction to expel it, but which, like the rats we tolerate in our back yards, may be very deadly to the complacent host. Later, we may be able to make some report on the type of infection, and now have some observations.

In the future we will add general quartz light treatment.

ANALYSIS OF JAW CASES

Number of Cases: 18 Children, 21 Adults (11 Male, 10 Female)

Cause
- Apparently associated with peridental infections, 33.
- 31 of these were associated with extraction during acute state of a peridental infection. Of these 31 acute infections, there were 2 following devitalization of the pulp with arsenic, and 1 following application of phenol to the pulp chamber.
- 1 associated with salivation, HgCl.
- 1 associated with extraction of an old root.

Other causes than teeth, 6
- 1 associated with gland enlargement and loosening of teeth.
- 1 following tonsillitis.
- 1 following measles.
- 1 following diphtheria.
- 1 associated with tuberculosis elsewhere in the body.
- 1 associated with upper respiratory infection in an infant.

Jaws effected
- Upper, 8.
- Lower, 32 (both jaws in one case of suspected syphilis).

Wassermann ....
- Negative, 17.
- No report, 18.
- Positive or partly positive, 4.

Salvarsan ....
- 8 cases.
- 3 with negative Wassermann improved.
- 3 with negative Wassermann, but no note of improvement.
- 1 with positive Wassermann, but no note of improvement.
- 1 with positive Wassermann, but treated before jaw was operated on.
- (2 cases with positive Wassermann had HgCl—2 and K.I. treatment only.)

Time elapsed between the appearance of first symptoms and the spontaneous throwing off, or the operative removal of sequestra in various cases. A total of 63 sequestrectomies, 8 of which were spontaneous.
- 1 at one week, bone-cutting operation on upper jaw—death.
- 1 at three weeks, spontaneous separation, upper jaw.
- 2 at one month.
- 2 at two months.
- 8 at three months.
- 7 at four months.
- 8 at five months.
- 8 at six months.
- 8 at seven months.
- 1 at eight months.
- 5 at nine months.
- 3 at ten months.
- 2 at eleven months.
- 1 at twelve months.
- 1 at seventeen months.
- 1 at twenty-four months.
- 2 at thirty months.
- 1 at thirty-four months.
- 1 at eleven years.

Number of operations ....
- 25 cases—only one operation was necessary.
- 14 cases—multiple operations, but about half of these were external drainages.

Deaths ....
- 1 baby, following a bone-cutting operation on the upper jaw one week after the onset of symptoms.

ANALYSIS OF OSTEOMYELITIS OF SKULL CASES

Authors 33	No. cases with available records 46 (2 mastoids)	
Radical........23	Radical Treatment.......37	Conservative Treatment.........9
Conservative.... 9	Dead..............25	Dead......................3
Undetermined.. 1	Living.............12	Living....................6
	Of the 12 living, 5 were reported too soon to be sure of, and in one there was a question as to whether the treatment was of a radical kind or not.	Of the 6 living cases, one was a mastoid, one was a fairly limited case, and one was reported too soon.

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ANALYSIS OF OSTEOMYELITIS OF SKULL CASES—*Continued*

Age	Wassermann	Vaccines used in:
Up to 10 – 6 10 to 20 – 9 20 to 30 – 18 30 to 40 – 10 40 to 50 – 2 60 – 1	Negative 16 Positive 0 Anti-syphilitic treatment 9 without results. 1 with vaccine and radical operation, recovery. 1 with sequestrectomies but reported too soon.	5 cases of those that recovered with radical operation. 2 cases of death with radical operation. 1 with sequestrectomies with recovery (mastoid case).
Male Female 28 18		

Bacteriology; reported here as designated in reports		Cause of death
Staph...........3 Strep............5 Staph. Aureus....5 Staph. Albus.....2 Short Strep......1 Non Homo Strep..1 Enterococcus.....1 Actinomycosis....1 Pneumococcus....1	Proteus-Staph.-Short Chain Strep..................1 Mixed with Strep. in short chains................1 Strep.-pneumococcus......1 Staph.-Gram-ng. Bac.......1 Staph.-Albus-Strep.........1 Strep.-Gram-pos. Diplococcus ....1 Staph.-Strep..............2	Basalar meningitis..............1 Meningitis ....11 Brain abscess..................12 Throm. Sup. Long. Sinus with Meningitis..................1 Pyemia with lung involvement...1 Pyemia with meningitis.........1 Cavernous sinus thrombosis.....1 Septic embolism of lung.........1 Lat. Sinus throm. with meningitis (mastoid case)...............1

CASES SINCE 1913–25

Origin	Frontal, 19. Frontals and others, 4. Antral-frontal, 2. Spontaneous, 12. Post-operative, 12. Trauma, 1.
Radical treatment	Dead, 11. Living, 8. 3 reported too early; 1 operated on after 2½ months' time.
Conservative treatment	Dead, 2. Living, 4. 1 reported too early.
Osteomyelitis recognized	Before operation..21 cases. At time of operation..2 cases. No note...1 case. Outer table uninvolved and extent of inner table involvement missed.................................1 case.

ANALYSIS CASES OBSERVED HERE

Age	10, 10, 17, 20, 20, 33.
	Male, 3. Female, 3.
Wassermann	Negative, 4. No report, 2.
Salvarsan treatment	3 cases, 2 died, 1 lived.
Bacteriology	Strep. 2. Short chain strep., 1. Strep.-staph., 1. Actinomycosis with a pus producer, 1.
Origin	Spontaneous, 4. Post-operative, 2.
Sinus of Origin	Frontal, 5. Sphenoid, 1.
Treatment and Results	Conservative in 6 cases. 3 dead. 2 cured. There was some bone cutting done in one of these that was immediately followed by spread of the disease. 1 still living after one year with head healed, but too early to call a cure.

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BENIGN BONY ENLARGEMENT OF THE CONDYLOID PROCESS OF THE MANDIBLE*

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In the last three years I have treated three cases of bony enlargement limited to the condyloid process of the mandible. A search of the literature several months ago succeeded in finding only one case which seemed comparable in any way to these, *viz.*, that recorded by Eckert.[1] Eckert's case has been mentioned and depicted (Fig. 1) by several other writers.[2,3] Further trouble in looking up the literature has been spared by Gruca and Meisels who recently[4] have collected 14 recorded cases and added three of their own.

Fig. 1.—Eckert's case of hyperostosis (Scudder.)

Case I.—C. McH., female, married, age thirty-five, was first seen on March 21, 1924. For about three years she had had slight pain and gradually increasing swelling in the region of the right mandibular joint, accompanied by a deviation of the chin to the left with malocclusion of the teeth.
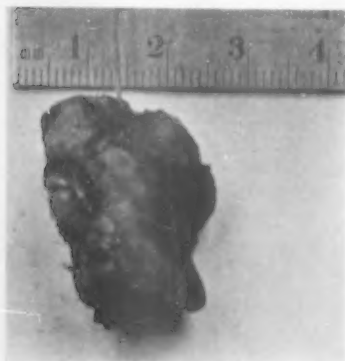
Fig. 2.—Enlarged condyle in Case I.

Examination showed visible enlargement beneath the right zygoma, with some tenderness, but no definite mass could be felt on palpation. The right ascending ramus of the mandible appeared to be longer than the left, and the whole lower jaw was pushed toward the left, with consequent malocclusion of the teeth. There was no limitation of opening of the jaws, though some crackling could be detected in the joint region on the right side.

Radiographic examination showed the right condyle of the mandible to be irregularly enlarged to about three times the normal size. The left condyle was normal.

General physical examination shows a well-developed woman, with no other bony enlargements or other significant abnormalities. Wassermann reaction negative.

April 1, 1924, under ether anæsthesia, through a Blair incision the right condyle of the mandible was excised by dividing its neck with chisel and mallet. The condyle was found to measure 3 cm. in its transverse diameter, was thicker than normal, and presented a lobulated appearance (Fig. 2). Histological examination revealed no evidence of inflammatory disease or pathological tissue of any kind—simply an overgrowth of bone and cartilage.

After the operation the mandible returned at once to its normal relation with the upper jaw, and after slight post-operative pain and tenderness in the wound the patient was discharged as well. A letter dated September 27, 1926, states that the patient has felt much better since the operation.

FIG. 3.—Case II, before operation, showing enlargement of left side of face.

CASE II.—R. L., female, single, age twenty-seven. Examined on April 28, 1925. For about a year she had noticed a gradually increasing downward enlargement of the left side of the lower jaw, with little or no pain, although she suffered from headaches. She sought relief because the shape of her face was changing.

On examination it could readily be seen that the left side of the face was larger than the right (Fig. 3), the chin being slightly deviated to the right. The left lower teeth did not come into contact with the upper teeth when the jaws were closed. There was no limitation of movement of the lower jaw. No masses could be felt, but the distance from the border of the zygoma to the angle of the mandible on the left side was 2.5 cm. greater than the same measurement on the right side. No other abnormalities were found on

FIG. 4.—Case II. Radiograph showing enlargement of left condyle.

physical examination. Radiographic and ocular examinations for pituitary disease were negative. Wassermann reaction negative. The X-ray showed a well-defined antero-posterior enlargement of the left condyle of the mandible with smooth margins, the

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coronoid shadow being much lower than normal (Fig. 4). Four months later the patient returned complaining that the deformity was increasing and that she was beginning to have pain in the region of the left mandibular joint. August 28, 1925, under colonic ether anæsthesia, through a Blair incision, the neck of the left condyle was exposed and the condyle excised with chisel and mallet. There was found a uniform bony enlargement in all directions. Unfortunately the specimen was cut to pieces in the laboratory. Dr. E. A. Case gave the following report of the histological examination: " The bone is enlarged and denser than normal. There are dense trabeculæ, and marrow spaces containing a rather cellular bone-marrow. Beyond hypertrophy and an increase in density, the bone is not diseased histologically."

After operation, the facial deformity disappeared completely (Fig. 5). The normal occlusion of the teeth was restored, although the patient complains of discomfort in mastication and vague pains about the head.

Bony enlargements of condyloid process present a definite clinical syndrome, *viz.*, slowly progressive vertical elongation of one side of the face, produced by lengthening of the ascending ramus of the m a n d i b l e, the chin being pushed over toward the opposite side, failure of the upper and lower teeth on the affected side to meet, and little or no interference with mo-

FIG. 5.—Case II. Patient after excision of enlarged condyle, showing return of facial contour to normal.

tion of the jaw. Gruca and Meisels discuss various views as to the etiology and pathology of this condition. Some of the reported cases suggest that middle-ear infection may stimulate an inflammatory hyperplasia and overgrowth of the epiphysis, but nothing definite is known as to the cause. The disease has been classified as osteoma, exostosis, hyperostosis, hypertrophy, inflammatory process, while Gruca and Meisels term it " overgrowth." In the two cases reported here there was no evidence of inflammation or true tumor formation.

Most of the recorded cases were successfully treated by the method employed here, viz., excision of the enlarged condyle.

CASE III.—This case differs somewhat from the others. The patient was a woman, aged forty-eight, seen on May 18, 1925.

Three years previously she first noticed discomfort in the region of the left man-

dibular joint, which for several months had amounted to severe pain at times, accompanied by difficulty in opening the mouth.

Examination showed slight fulness and tenderness over the left mandibular joint, and considerable limitation in opening the jaw, on account of pain caused by movement. The patient was edentulous, making it difficult to determine whether the jaw deviated to the opposite side. At any rate, this sign, if present, was insignificant. There was no lengthening of the left ascending ramus.

X-ray examination (Fig. 6) showed an oval enlargement bulging out the anterior aspect of the left mandibular condyle. The enlargement had a well-defined margin enclosing an area of less density than the surrounding bone.

Operation May 16, 1925, under ether anæsthesia, consisted in removal of the left condyle of the mandible through a Blair incision. The condyle was removed in several pieces, and the anterior aspect consisted of a thin shell of bone enclosing what appeared to be blood and marrow—clinically a bone cyst. Microscopically, the bone itself appeared to be normal, with evidence of hemorrhage on the surface of the cavity. No giant cells or tumor cells of any kind were found.

FIG. 6.—Case III. Cystic enlargement of left mandibular condyle.

The operative wound healed in one week, without complications. One month after operation the patient stated that she was without pain, but that her jaw was still stiff and could not be opened wide. This is to be expected such a short time after operation. In a letter dated September 28, 1926, patient states that she now has no discomfort whatever in her jaw.

This third case differs from the others in that the overgrowth was cystic rather than solid. The literature records no cases of bone cysts limited to the condyloid process of the mandible. The principal symptoms were limitation of motion and pain, rather than visible deformity.

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CEREBROSPINAL FLUID LEAK DUE TO A FISTULA
OF THE CISTERNA MAGNA

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CEREBROSPINAL fluid leaks occur very rarely and when they do occur they usually drain through the ears; it follows that a direct fistula of the cisterna magna is a very rare condition and one that offers an unusual opportunity for studying the effect of various drugs upon the fluid. For this reason we are reporting the following case, in which the patient suffered a stab wound of the posterior cervical region which presumably entered the cisterna magna, with a resulting fistula from which cerebrospinal fluid drained for seventeen days. On the twelfth day following the injury a cerebrospinal meningitis developed, from which the patient completely recovered. During the course of the illness gentian violet, phenolsulphonephthalein, methenamina, and sodium salicylate were administered and observations were made on the effects of each upon the cerebrospinal fluid.

CASE REPORT.—A well-developed and well-nourished male negro, twenty-eight years of age, unconscious and in first degree shock, was brought to the Louisville City Hospital, November 7, 1925. He had a stab wound of the posterior cervical region. A physical examination showed no other injury or abnormality. The stab wound was in the posterior midline and extended about six centimetres from the base of the skull downward and to the left. After the wound had been irrigated and closed with deep sutures, a rubber drain was placed in the dependent portion.

The following morning the patient had recovered from the shock and his condition seemed fairly good. Twelve hours after admission he vomited once, the vomiting being projectile in type. During the day the patient was quiet. For an hour during the evening he had pain at the site of the wound, but rested well during the night.

On the third day he had a convulsion which lasted for a few minutes and was followed by a severe headache. A profuse, clear, serous discharge, presumably cerebrospinal fluid, was noticed on the dressing. The temperature, which had been normal, rose to 99; the pulse rate was 88; respiratory rate 20. For the next twelve days the headache continued with periods of remission, the pain being fairly well localized in the temporal and occipital regions. During this time, the temperature ranged between 99 and 99.8; the pulse rate remained at 80; and the respiratory rate at 20. On admission the blood-pressure was: Systolic 120, diastolic 60; three days after admission it had increased to systolic 160, diastolic 60, where it remained during the patient's stay in the hospital. After the third day the cerebrospinal fluid flowed freely from the wound. The wound was slightly infected but it healed readily, except for one sinus track through which the fluid escaped.

On the twelfth day the temperature rose to 101; the pulse rate to 90; and respiratory rate to 20. On this day a glass female catheter was passed through the sinus track to the bottom of the wound and a radiographic examination with a metal probe in the sinus track showed that the tip rested on the arch of the atlas. The drainage around

the catheter was blocked with flexible collodion, which held without leakage for about twelve hours. Repeated observations of the quantity of the cerebrospinal output showed that it remained fairly constant, about 400 c.c. daily. At the time the catheter was inserted a lumbar puncture of the spinal canal was made. The cerebrospinal fluid thus obtained was turbid and contained 400 leucocytes per cu. mm., 60 per cent. being polymorphonuclear. Repeated punctures and bacteriological examinations of the fluid from the lumbar region revealed a non-hæmolyticus streptococcus, staphylococcus albus, and an unidentified Gram-positive bacillus. The spinal manometer reading in both the lumbar and the cervical regions was 16 mm. of mercury.

On the fifteenth day the temperature was 103.6; the pulse rate 110; the respiratory rate 28. The severity of the headache and its location were unchanged. Kernig's sign was positive. The pupils were normal. There was no change in the cerebrospinal fluid drainage and bacteriological examinations gave the same results as before.

On the seventeenth day the temperature, pulse, and respiration were normal and remained so thereafter. The drainage of cerebrospinal fluid stopped suddenly on the nineteenth day, while the glass catheter was still in the wound. The headache became very severe after the drainage stopped, but it could be fairly well controlled with aspirin and by limitation of the fluid intake. The symptoms gradually subsided and the patient was discharged from the hospital on the twenty-first day, apparently well.

The following observations on the cerebrospinal fluid were made after the administration of the indicated drugs:

Gentian Violet.—Twenty c.c. of a one per cent. solution of gentian violet was given intravenously. There was no visible coloring of the cerebrospinal fluid during a twenty-four-hour period of observation.

Phenolsulphonephthalein.—One c.c. of phenolsulphonephthalein injected into the lumbar subarachnoid space, with the patient in a recumbent position, first appeared in the fluid draining from the cervical region in one hour and 20 minutes. Fifteen per cent. was eliminated in the urine in two hours.

Methenamina.—Thirty grains of methenamina administered per os appeared two hours later in the cerebrospinal fluid. It was necessary to acidify the fluid before the formaldehyde test was positive.

Sodium Salicylate.—One hundred and twenty grains of sodium salicylate was administered per os. The quantity of the fluid output decreased ten c.c. during the next five hours, but this was within the variation in the rate of fluid loss at the time.

Discussion.—According to DaCosta,[1] cerebrospinal fluid leaks rarely follow skull injuries. When they do occur, they usually follow basal fractures of the skull and appear in one or both ears; or after fractures of the frontal bones there may be a leak from the ears, the cerebrospinal fluid appearing, however, only when there is a break in the mucous membrane, the dura, and the arachnoid.

"Treves[2] states that cerebrospinal fluid cannot flow from the ear in fractures of the middle fossa—(1) unless the line of fracture crosses the internal meatus; (2) unless the prolongation of the membrane into the meatus is torn; (3) unless a communication exists between the internal ear and tympanum, and (4) unless the drum-membrane is torn."

Miles[3] states that in a case in which the drum-membrane of the ear has been ruptured, cerebrospinal fluid may flow from the ear even when the skull is not fractured. In such a case, the cerebrospinal fluid flows inside the sheath of the auditory nerve, passes into the vestibule, through the lamina cribrosa, and from the vestibule into the middle ear, finding an exit through the rent in the drum-membrane.

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Dandy [4] states that three types of treatment have been tried in cases of septic meningitis:

" (1) Repeated lumbar punctures (intermittent drainage); (2) continuous drainage from, (a) the spinal canal, (b) the cisterna magna, (c) the pontine cisterna, (d) the lateral ventricles, and (e) the subarachnoid space; and (3) irrigations of the subarachnoid space."

He considers that continuous drainage from the cisterna is the operation of choice, and he reports three recoveries in a series of four cases in which the patients were treated by continuous drainage from the cisterna magna.

Moise [5] reports a case of staphylococcus meningitis secondary to a sacral sinus in which recovery followed treatment by lumbar laminectomy with drainage. He used drainage in this region because the infection followed the removal of a pilonidal sinus and this was considered the portal of entry.

In our own case, meningitis was due to a mixed infection, the portal of entry being through the stab wound between the occiput and atlas. By keeping the wound open, continuous drainage from the cisterna magna was maintained. The infection was apparently not limited to the spinal region. Recovery took place before spontaneous closure of the sinus.

Various experimental studies have been reported which were undertaken with the purpose of determining the effect of the administration of dyes upon the cerebrospinal fluid. Solomon [6] used phenolsulphonephthalein to determine the circulation of the cerebrospinal fluid with reference to the treatment of cerebrospinal lues. After injecting one c.c. of phenolsulphonephthalein into the lumbar subarachnoid space, he recovered the dye from the cisterna magna, where it appeared in from seven to seventy minutes. He then injected the dye into the cisterna magna and found that the average length of time in which it appeared in the lumbar subarachnoid space was ten minutes. The time consumed in the passage of the dye from the lumbar subarachnoid space to the cerebral ventricles averaged twenty-five minutes, and from three to fifty c.c. of fluid had to be withdrawn before the dye appeared. In one case it passed from the cerebral ventricles to the lumbar subarachnoid space in fifteen minutes; in two cases it passed from the cisterna magna to the cerebral ventricles in eight, and twenty-eight minutes, respectively. As a result of these observations and of an experiment to determine the diffusion of the cerebrospinal fluid, he offers the following conclusion:

" There is a free communication between the lumbar subarachnoid space, the cisternal subarachnoid space, and the lateral ventricles. Under ordinary conditions, however, it is probable that there is not very much movement from one locus to another of the substances introduced into the cerebrospinal fluid. The movement of the introduced substances may depend either on circulation of the cerebrospinal fluid, or, what is more probable, on a diffusion of the substances due to osmotic and specific gravity effects."

Weston [7] made injections of one c.c. of phenolsulphonephthalein (neutral), with specific gravity 1.0061, in twenty-eight cases of catatonic dementia præcox and in seventeen cases of paresis. He did not find the dye in the

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fluid drawn from the cisterna magna at any time up to five hours after it had been injected into the lumbar subarachnoid spaces. The period of time between the injections of the dye into the lumbar subarachnoid space and its appearance in the urine was used by Weston as a diagnostic sign. He found this period varied from twelve to sixty-eight minutes in cases of paresis, and from twenty-five to 104 minutes in cases of catatonic dementia præcox. From these findings he drew the conclusion that the absorption of the dye is from the lumbar region, and that it is delayed in these two diseases. The time of its appearance in normal individuals is stated by Dandy and Blackfan [8] to be six minutes and by Mehrtens and West,[9] four to ten minutes.

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OSTEOPLASTIC SUPPORT OF THE SPINE IN POTT'S DISEASE

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THOUGH the problem of a constant fixation of the section of the spine affected by tuberculosis is satisfactorily solved by means of a series of operations of a type similar to Albee's method of surgical treatment, this by no means may be said with regard to the support of the diseased vertebræ.

Bitter experience, based on observations carried out for a great number of years, has led the majority of surgeons to the conclusion that it is indeed indispensable to wear orthopædic corsets for a long period even after an osteoplastic fixation of the diseased vertebræ in order to avoid increasing kyphosis. Unfortunately it is either impossible or too expensive for most patients to carry out systematically this post-operative treatment. Orthopædic corsets require systematical medical attention and repeated altering and repairing which is difficult or even impossible for people living at great distances from the surgeon.
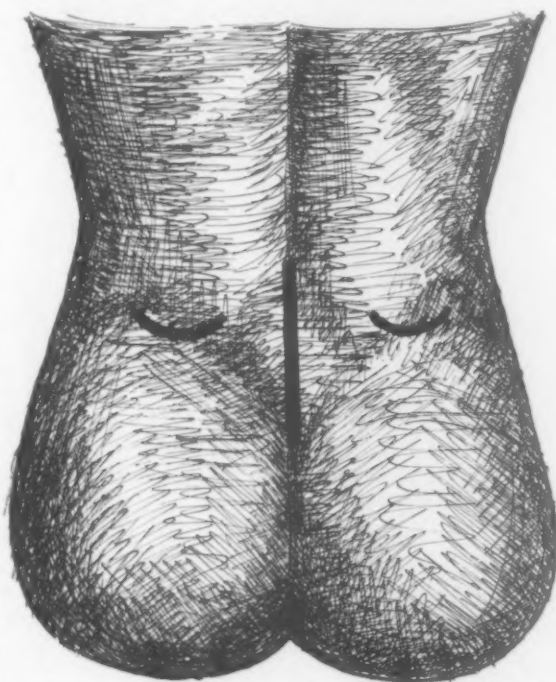
FIG. 1.—Showing three relative positions of the iliac crests and the lumbar spines.

And in Russia it is entirely impossible, owing to a lack of means, for the great majority of the population to purchase orthopædic corsets.

All these considerations have led us to seek a remedy by a surgical method of treatment which would in addition to immobilizing the affected section of the vertebral column also support it. This we found practically possible when the disease is located in the lower section of the vertebral column, *i.e.*, in the lumbar and the last two dorsal vertebræ.

In such cases we transfer the weight of the trunk from the diseased vertebræ to the pelvis by the following operative methods.

I. *The Method of Transverse Support.*—This operation may be applied in cases of an affliction of both the IV and V lumbar vertebræ together or

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of each of them separately when, owing to their sagging the spinous process of the IV lumbar vertebra is situated below the line connecting the uppermost points of the cristæ ilii.

The operation we present is made as follows:

1. A longitudinal incision of the skin beginning at the apex of the spinous process of the second lumbar vertebra (L II) and extending to the junction between the upper and medial thirds of the sacrum (Fig. 1).

2. The f a s c i a lumbodorsalis is dissected at the sides of the spinous process L II, III, IV, and V perpendicularly to their oblique surface. Then the spinous processes and the arches of the three lower lumbar vertebræ are denuded of their periosteum.

3. The ligamentum interspinale is d i s s e c t e d between L II and L III; the spinous processes of these vertebræ are dissected at their bases by means of Liston's forceps and reflected to the lower corner of the wound.

Fig. 2.—Showing tibial graft in place, forming transverse supporting rafter.

4. A semi-crescentic incision with its convexity directed downwards is made on both sides of the vertebræ in the region of the uppermost points of the cristæ ilii (Fig. 1).

5. Having drawn upwards the skin flap formed by means of the abovementioned incision, we vertically dissect the fascia lumbo-dorsalis at the medial corner of the wound and denude within the limits of the wound the crests of the ilium with a blunt dissector. Then a groove is made with a gouge on the upper margin of the latter.

6. A firm, long, curved forceps is introduced at one end of this wound and passed beneath the muscle erector trunci; in a similar manner it is brought out through the analogous wound on the other side of the vertebral column. By opening the forceps we form beneath the above-mentioned muscle a broad canal.

7. After measuring the space between the ends of the grooves in both cristæ ilii, we form a rafter of a similar length and 1½ cm. thick out of the cristæ tibiæ.

8. The end of this rafter while being held by the forceps is passed

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beneath both muscles erector trunci and beneath the spinous process L III and its ends are then placed in the grooves formed in both cristæ ilii.

9. The soft tissues which had been separated from (Fig. 2) the cristæ ilii are fastened over the ends of the rafter by several catgut sutures and the semi-crescentic incisions of the skin are sutured with silk.

10. The spinous processes L IV and L V suspended on the ligamentum interspinale are, according to the amount of space either inserted beneath the middle of the rafter, or placed sidewise on the denuded arches of those vertebræ, or entirely removed.

11. The soft tissues separated from the spinous processes and arches in the longitudinal wound are fixed with a series of catgut sutures placed one above the other as follows: First, through the muscles and the adjoining periosteum, a n d next, through the fascia lumbo-dorsalis. T h e n the skin incision is sutured with silk.

As a result of this operation the weight of the trunk from the affected

Fig. 3.—Z-shaped incision to expose lower dorsal and upper lumbar vertebræ.

vertebræ is transferred by means of a powerful spinous process (L III) to a firm osseous rafter.

After the operation is completed the patient is kept lying on his back for six weeks. By the end of the second week he is allowed to rest for an hour or two daily, lying on his abdomen with a hard pillow placed under his chest.

After six weeks the patient is gradually trained to sit and seven weeks after the operation he begins to walk, having no need of any kind of corsets.

A support of the spine by means of an orthopædic corset in these instances is even contra-indicated; for owing to the effect of the load of the trunk the osseous rafter grows and consolidates more rapidly (as it has been proved by röntgenograms) whereas the m.m. erectores trunci placed over it appear to be a vis a tergo securing a reclination which is most important under the circumstances.

II. *Method of Oblique Support.*—In cases of an affection of the last two dorsal or the first three lumbar vertebræ we perform an oblique support of

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the diseased section of the spine, creating a trestle consisting of two long osseous transplants and fixing the lower ends of the latter in cristiæ ilii. The upper ends of the trestle are fixed in a crosswise manner beneath the process of the sound vertebra which is situated above the diseased section of the spine.

We perform this operation in the following manner:

1. A Z-shaped incision of the skin is made with its lower horizontal part situated at the level of the cristæ ilii and within the limits of the external margins of both musculi erectores trunci. The upper horizontal incision is made parallel to the lower one and just above the spinous process which serves as a support. After the uniting oblique incision is made. the triangular skin flaps are separated from the sub-lying aponeurosis and drawn externally (Fig. 3).

2. The soft tissues are separated with a resection knife along both sides of the apices of the spinous processes beginning at the one which is to serve as a support, and reaching to the last lumbar vertebræ, parallel to the lateral surfaces of spinous processes and extending to depth of bone.

FIG. 4.—Forming a canal in which the transplant grafts are to be lodged.

3. The spinous processes and the dorsal surfaces of the arches are denuded of their periosteum up to the transverse processes.

4. The ligamentum interspinale is dissected at the apex of that spinous process which is to serve as a support. All spinous processes situated below it are dissected at the base by means of Liston's forceps and reflected downwards.

5. At both ends of the lower horizontal incision the fascia lumbo-dorsalis is dissected by means of a vertical incision about 5 or 6 cm. long penetrating to the cristæ ilii.

6. A groove is formed by means of a groove gouge in the crest of the ilium on both sides of the spine for the purpose of fixing the lower ends of the transplantates.

7. A long firm forceps is passed through the above-mentioned incision in the fascia lumbo-dorsalis beneath the muscle erector trunci. This forceps being directed upwards is pushed beneath the spinous process which is to serve as a support. By opening the forceps we form a canal in which the transplantates are to be placed (Fig. 4).

8. Having measured the distance between the apex of the spinous process intended for a support and the groove in the crest of the ilium and having added 2 or 3 cm. for insertion and crossing, we form an osseous rafter of a corresponding length and 1 to 1½ cm. thick out of each of the crista tibiæ, gradually decreasing the thickness of the rafter almost to half of this size in the direction of the upper end of the transplantate.

9. Both osseous rafters are introduced, the narrow end foremost, through the incisions in the fascia lumbo-dorsalis and into the canal formed beneath muscle erector trunci with the forceps until they cross beneath the spinous process which is to serve as the support. The upper ends of the transplantates are inserted beneath the muscles of the opposite side and the lower are placed in the groove formed in the iliac bones (Fig. 5).

10. The vertical incisions in the fascia lumbo-dorsalis are sutured with catgut above the lower ends of the transplantates.

11. The spinous processes which had been drawn downwards are then laid with their lateral surfaces
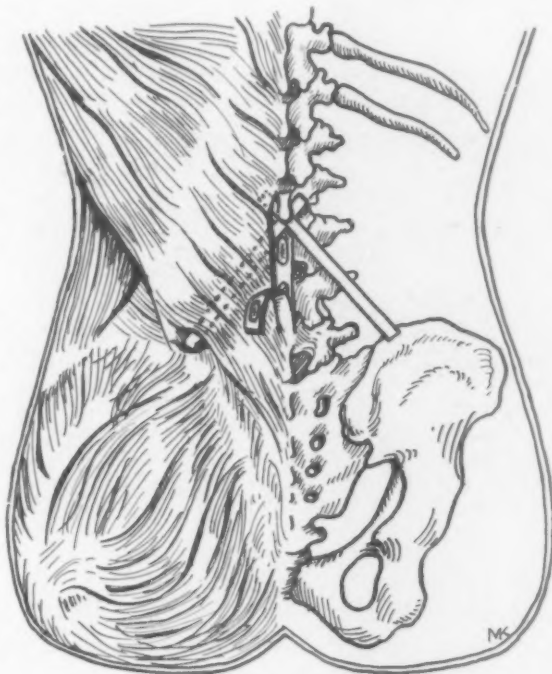
Fig. 5.—Osseous grafts from tibial crests in place.

along the medial line up to the point of intersection of the transplantates.

12. The long muscles of the back are sutured with catgut along the medial line in region of intersection of transplantates, ligamentum interspinale connecting spinous processes which had been dissected also included in suturing.

13. The fascia lumbo-dorsalis is thoroughly sutured with catgut along the medial line above the muscular layer.

14. The skin incision is sutured entirely with silk.

The post-operative treatment and cure are identical with those used after transverse support of the spine. As in the first instance, the patients are allowed to sit six weeks after the operation, and to begin walking without corsets by the end of the seventh week.

As yet we have applied this surgical method in only 10 cases, but judging from clinical observations and numerous röntgenograms our theoretical calculations have so far come true that we are convinced that this method of osteoplastic support will find a place in the surgery of the spine.

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OPERATIVE RELIEF OF LARYNGOSTENOSIS*

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of St. Paul, Minn.

I wish to report a case of laryngostenosis in the treatment of which a procedure was adopted which, apparently, has not been used before.

A woman of about forty years, came to see us for a severe stricture of the larynx. She had been treated for one year, as she said, for asthma. There was such a formidable stridor that it seemed she might choke in the office. She was unable to speak above a whisper. A year previously she had started to lose her voice. A cough had come on at that time, and a very severe sore throat. She had lost 25 pounds in weight since that time. During the last six months the inspiration had become labored and prolonged, with a loud stridor. The dyspnœa robbed her of her sleep. She was unable to run or even walk. She had been in good health according to her statement, until the present trouble began. There was no tuberculosis in her family. Her husband appeared to be very well and denied any venereal infection.
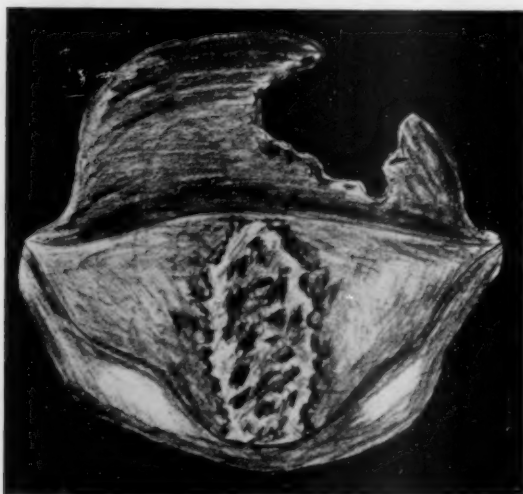
Fig. 1.—Ulcerated and stenosed larynx.

The laryngoscope showed a great destruction of the epiglottis; the larynx looked like an ulcerating crater (see Fig. 1). One could not see into the trachea, the larynx having a very narrow and tortuous lumen, and presenting on all sides, a bulky thickening, with an irregular ulcerated surface, partly covered with dirty looking material. A Wassermann test was ordered without delay and proved to be four plus. A salvarsan (o, 6) injection, followed by protiodide of mercury internally, caused a prompt change in the appearance of the epiglottis and the larynx, and also in the breathing and general condition. Within one week the patient could breathe easier, though dyspnœa was still present. The epiglottis very soon appeared healed and was now pale, but the false and true cords could not be made out. All of the ulcerated parts were paler and cleaner. A cicatricial stenosing change seemed to go hand in hand with the healing, and was undoubtedly the cause that the dyspnœa grew worse again after the first improvement. Soon her breathing became even as bad as before, although the larynx kept improving in appearance.

Six weeks after the first salvarsan injection, it became necessary to operate. The dyspnœa was again very severe, almost extreme. Novocain 1 per cent., with eight drops of adrenalin to the ounce, was used for the skin and the muscles. Some of it was injected on each side into the area where the superior laryngeal nerve reaches the side of the larynx, and penetrates the thyro-hyoid membrane. The skin was incised two and a half

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inches horizontally across the middle of the thyroid cartilage. The sterno-hyoid and thyro-hyoid muscles were cut through, and the thyroid cartilage was freed for one inch on each side of the midline. The patient laid with the head a little lower than the shoulders. Now before opening the larynx, the table was tilted to produce a moderate Trendelenburg position to avoid aspiration of blood. The cartilage was then divided in a zig-zag manner, which can best be understood by examining the sketches (Figs. 2 and 3). Two projections were thus formed, one on each side, which met with their rounded and strong tips after the two halves of the cartilage had been pulled apart. By directing the incision so that the upper tooth had a slightly downward direction, while the lower one was pointing
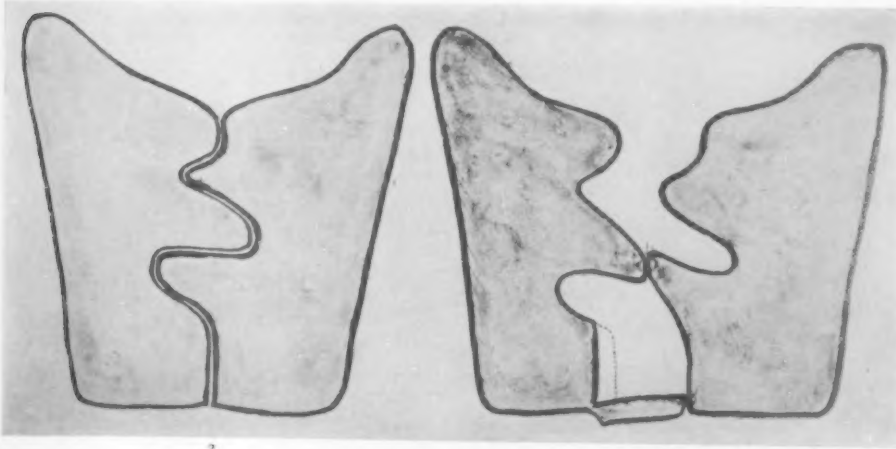
FIG. 2.—Incision made into thyroid cartilage.
FIG. 3.—Incision, spread apart.

a trifle upward, their tips met so that the lower tip was a little above the upper. We had carefully avoided opening the mucosa during this step of the operation. The breathing became improved even before the mucosa was cut. Novocain with adrenalin was now applied.

With a fine needle, we injected a few drops of a stronger cocain solution through the mucosa into the larynx before incising it, and waited a little while. The violent attack of coughing, which otherwise accompanies the division of the mucosa, was thus avoided. The larynx could then be rapidly opened by simply dividing the mucosa which had been thoroughly blanched and anæsthetized. There was practically no bleeding. We had observed on previous occasions, that the cartilage may well be cut without simultaneously opening the mucosa. This prevents serious bleeding into the air passages, and the very unwelcome fits of coughing that result.

The breathing became at once entirely free, through the wound. The stenosis was all in the larynx, none of it in the sub-glottic area or in the trachea. The cricoid remained therefore untouched. The two halves of the thyroid cartilage were now held apart with linen threads, and the whole larynx could freely be inspected. It was diseased down to the true vocal cords. The right false cord especially was protuberant, soft and flabby. It almost looked like an inversion of a Morgagni pocket, which, as you know, occurs as a definite pathological entity. This mass was grasped with a forceps and resected. Now attempts were made to splint the larynx with a short O'Dwyer intubation tube of adult size. It was, however, too short to engage sufficiently into the trachea. A long hard rubber intubation tube, marked for a child of thirteen years, was then inserted, and rested in place comfortably without pressure. Strange to say, the patient had ample air through it and was very satisfied with this much improvement of her respiration. She had been used to much less air for such a long time. The two sides of the thyroid

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cartilage, as mentioned before, had been pulled apart till the tips of the two corresponding projections rested on each other. This caused a gap in the line of incision of seven or eight millimeters at the upper end, and about six or seven at the lower border of the cartilage. The two corresponding cartilage projections were now fastened by a silk suture, so that their tips met firmly. There seemed to be little danger of a slipping back into the original place, even should the thread soon cut through.

This procedure was surely much simpler and better than the implantation of a brace, which has to be taken from a distance and brought up by a long pedicle. Rather compli-
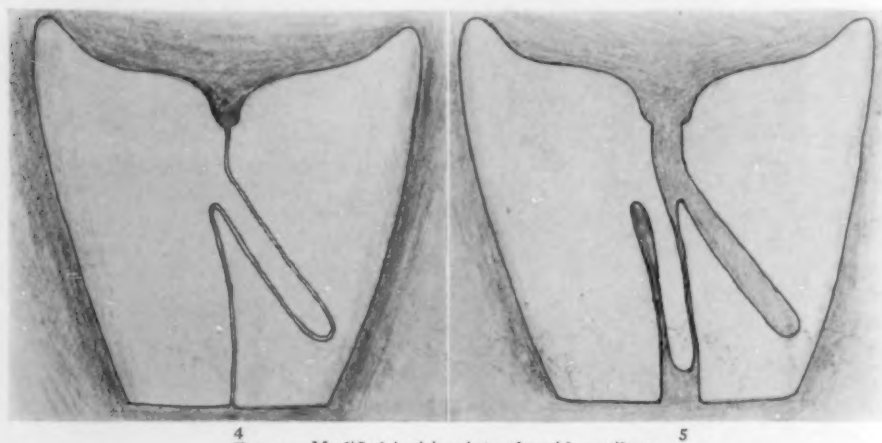
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Fig. 4.—Modified incision into thyroid cartilage.
Fig. 5.—Cartilaginous projection lifted over into the median cleft of the laryngofissure.

cated operations have been tried with varying results. There is always much irritation and infection in these wounds, and the parts are greatly disturbed by the frequent coughing.

The lowermost portion of the incision in the thyroid cartilage, was vertical on account of the vocal cords. This was, however, just the region which might again become stenotic. Therefore, a small cartilage flap was cut by a vertical incision along the edge on the right side, the lower end remaining attached by its perichondrium. This piece was thrown across the lower part of the gap and fixed to the other side by a linen suture. To counteract the tendency to formation of a fistulous opening, and, also to contraction of the laryngofissure, two flaps from the adjoining muscles were thrown over and partly into the opening. The skin was loosely united with a few interrupted sutures.

The patient felt quite well at the end of the operation. The foot end of the bed was raised, and was kept raised for a week. Two days after the operation the intubation tube was coughed out and was not reinserted. For ten days part of the breathing was through the wound. After this the wound promptly improved in appearance.

Our patient left the hospital two weeks after the operation. The antiluetic treatment was to be kept up, but unfortunately this woman became reckless, left town and disappeared.

Though I have not had an opportunity to operate on a second case so far, I have tried out on the cadaver some modification which seems to be an improvement. In making the laryngofissure, the incision is curved in a manner as to cut out a long, rather narrow, strip in an oblique downward direction from one-half of the thyroid cartilage, though in continuity with the other. The direction and shape of the incision is best understood from the sketches (Figs. 4 and 5). This piece of cartilage is then lifted over into the vertical gap of the lower portion of the laryngofissure and makes here a firm and

exactly fitting interposition. Where the notch at the upper border of the thyroid cartilage is deep, it is better to place the base of the wedge higher up, *i.e.,* at the notch itself. If the larynx is not severely stenosed and does not require any intralaryngeal operating, as for instance in asphyxia from paralysis of the posterior crico-arythenoid muscles, the mucosa need not be opened. The wound healing and post-operative course are then very simple. This so-called " posticus paralysis," which is a most unfortunate complication when it occurs after thyroidectomy, may thus be relieved by a comparatively simple operation, and the indefinitely prolonged wearing of a tracheotomy cannula can be avoided.

The method of widening the larynx in the manner described was so satisfactory and appeared so different from the straight up and down laryngofissure, that it changed it in reality into a laryngoplasty, and made it seem of sufficient practical value to be reported.

POST-OPERATIVE PULMONARY EMBOLISM*

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THE unexpected and too frequently fatal occurrence of pulmonary embolism after operation still remains somewhat of a clinical mystery. Its study leads to many questions starting with the physiology and chemistry of the blood. It also involves mechanical factors and we may again consider a series of this unwished for post-operative complication.

From the records of the Presbyterian Hospital I have found thirty instances—seventeen men and thirteen women—in the past fourteen years. Probably there have been many more, certainly many more without fatal termination. All emboli following either simple or complicated labor cases have been omitted.

Type of Operation.—The operations have varied. All have not been in the lower abdominal cavity. The enumeration has been as follows:

Herniorrhaphy—3 inguinal, 2 post-operative abdominal; 5 cases.

Hysterectomy (fibroids)—4 cases.

Cholecystectomy and post-operative hernia—1 case.

Bone operation, neck of femur—1 case.

Bone transplant in femur—1 case.

Removal of fibroid from uterus—1 case.

Appendectomy—1 case.

Cystotomy (suprapubic)—3 cases, 2 first stage prostatectomies, 1 stone in bladder.

Laminectomy—1 case—osteochondroma of the dorsal vertebræ.

Paracentesis abdominis for carcinomatosis following carcinoma of the stomach—1 case.

Prostatectomy—2 cases

Ectopic tubal rupture with abdominal lipectomy—1 case.

Pelvic abscess—1 case.

Gastro-enterostomy (carcinoma of stomach)—1 case.

Superficial operation for removal of necrotic tissue involving penis and scrotum after electrical burn—1 case.

Varicose veins of leg—1 case.

Insertion of radium in prostate—1 case

Pyelotomy (for stone)—1 case.

Closing a colostomy—1 case.

Thyroidectomy—1 case.

The type of anæsthesia used was as follows:

Ethylene alone—4 cases.—Closing colostomy; insertion of radium in prostate; operation on neck of femur; thyroidectomy.

Ethylene—Ether—1 case.—Hysterectomy.

Gas Oxygen alone—no cases.

Gas Oxygen Ether combined—14 cases.—Pyelotomy; ventral hernia; hysterectomy—

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2 cases; post-operative hernia; removal of burned tissue; gastro-enterostomy; cystotomy—2 cases; drain pelvic abscess; ectopic pregnancy and lipectomy; prostatectomy; removal of fibroid; cholecystectomy and post-operative hernia.

Novocaine intra-sacral—1 case (Prostatectomy).

Ether alone—8 cases.—Herniotomy—2 cases; varicose veins; laminectomy; cystotomy; appendectomy; hysterectomy; bone transplant—ununited fracture of femur.

No anæsthesia given—1 case.—Paracentesis abdominis.

No anæsthesia mentioned on record—1 case.—Hernia (probably ether).

Autopsy was made in twelve instances.

The average ages of the men patients was 53.3 years, while that of the women was 44.1 years. This difference was influenced by the fact that operations on women are performed in earlier years for infection, fibroids, etc.; many men present themselves late in life for prostatectomies.

The number of deaths was 23; a mortality of 77 per cent. The non-fatal cases were pyelotomy, ventral hernia, post-operative hernia, electric burns, gastro-enterostomy, cystotomy for stone and operation on neck of femur. A fear of death before and immediately during the embolism was manifested only by 4 patients as far as the records show.

The operative wound was infected in 12 of the patients. Sometimes this was manifested simply by redness, not by pus.

Post-operative fever, usually starting immediately after the operation, was present in all but 5 patients.

The presence of a leucocytosis, taking a count of over 7000 cells per cubic mm., was present in all but four instances.

The average time elapsing between operation and onset of symptoms in the 23 fatal cases was about seven days, the longest being twenty-five days, the shortest one day—of which latter interval there were four instances.

Thrombosis was noticed in 7 cases; once the patient herself called attention to it. This thrombosis occurred in the leg six times and the thigh once. In one instance it involved both legs—a non-fatal case, pyelotomy.

The symptoms of embolism first noticed were usually sharp pain in the chest, frequently referred to the midline and substernal or epigastric. In some instances the pains were lateral, as pleuritic pain. Cough, a rise in temperature and beginning chest findings followed in the average case, which survived a few days. The records show that only 11 patients gave positive chest findings. This is explained partly by the fact that many of the emboli were massive and death followed within a few minutes, not permitting chest examination. In other cases no chest examination was made and recorded.

The chest examinations in the patients well watched gave at first obscure information—there were no findings on percussion and very few on auscultation, pain alone dominating the field. At first in an average case which survived long enough to give an opportunity for chest examination, crackling râles would be heard—most frequently over the lower lobes, rarely on both sides. Then followed changes in vocal fremitus and in a few days dulness and pneumonic-like signs.

De Quervain says that three-fourths of all true post-operative deaths

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after operations on the stomach are caused by lung complications—emboli, pneumonia and gangrene of the lung. Wharton and Pierson [1] consider that 50 per cent. of the deaths following gynecological operations are caused by embolism alone. At St. Mary's Hospital, Rochester, after 57,000 major operations the mortality from pulmonary embolism equalled 0.07 per cent. Cutler and Hunt [2] found 3.52 per cent. post-operative pulmonary complications in 1562 cases—mostly emboli—and they express the further belief that 1 of every 28 patients operated upon for major surgical procedure will have pulmonary complications, while 1 in 142 will die from such complications. Wermbter (Zentralbl. f. Gynäk, vol. lxix, pp. 1560–1566, July 11, 1925) after 13,000 gynecological operations found embolism in 0.5 per cent. Ochsner [3] found at Augustana Hospital that pulmonary embolism accounted for

	Per cent.
7 deaths in 16,696 operations	0.042
5 deaths in 5,275 laparotomies	0.1
1 death in 528 hysterectomies	0.5

The common physiologic facts of thrombosis are not here discussed in a clinical review of post-operative pulmonary embolism, but for the sake of mutual understanding, we may say that if certain elementary factors are absolutely necessary to produce intravascular thrombosis of blood, they may be:

1. Thrombokinase derived from the body tissues—probably liberated by a wound trauma—finds its way *via* lymphatics or an open vein into the blood stream in small amounts.

2. Venous stasis must be present in or near the great veins. Other factors as the presence of bacteria, toxins causing corpuscle disintegration, and trauma aid these two principal ones.

The first formed portion of a thrombus is pale; it contains an excessive proportion of platelets which become agglutinated into mural masses and eventually stick to the vessel wall. Some of the platelets break down to liberate thrombokinase and the mechanism of clotting has started, the resulting clot containing blood-cells and fibrin being dark in color. This clot may extend to the next anastomotic branch.

It has been shown (Sheen, *Brit. M. J.*, vol. ii, p. 950, November 22, 1924) that intravascular clotting does not follow intravenous injection of thrombin, when the blood is in a condition of circulation. Likewise an increase of the amount of calcium in the blood over the maximum requirement for clotting purposes may cause a reduction of clotting power.

Intravascular injections of commercial peptones and hirudin extract from the buccal cavity of the leech retard blood coagulation—but their use is not practical from a clinical standpoint.

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[1] J. A. M. A., vol. lxxix, pp. 1904–1910, December 2, 1922.

[2] Arch. Surg., vol. i, pp. 114–157, 1920.

[3] ANNALS OF SURGERY, vol. lxxii, p. 91, 1920.

From a pathological viewpoint, thrombi may be divided into two classes: aseptic, which is friable and liable to become detached and assume embolic power only in the early stages of its development; septic thrombus, which is in a constant state of softening and disintegration and therefore may constantly give off embolic fragments and be a greater menace.

The pathology may be reduced to simple terms depending on the size of the embolus, its septic or aseptic character and the size and position of the occluded artery.

First Group.—A large embolus with practical occlusion of the pulmonary artery on one or both sides cutting off blood from one or more lung lobes. Pulmonary œdema follows, with death in all but a small percentage of cases.

Second Group.—Moderate-sized emboli which slip past the main artery opening and occlude smaller branches, resulting in pulmonary infarcts. A hemorrhagic consolidation of the infarcted lung or lobe follows. Pleurisy, gangrene, abscess or pneumonia may follow. This type gives a mortality of 12 per cent. to 15 per cent.

Third Group.—Small emboli—often unnoticed—nearly always undiagnosed. Small infarcts in the lungs may follow but there are few physical findings in the chest, little fever, rare hæmoptysis and no deaths unless the infarct is septic and leads to empyema or lung abscess.

The lung has blood supply from the bronchial arteries which may hold the tissue alive for a short time after complete plugging of the pulmonary. If the patient survives a few hours, there is found congestion and œdema of the lung tissue proper from this source.

The symptoms vary with the type of post-operative embolism. Usually the sooner after operation the embolism occurs, the higher the mortality. Massive embolism commonly occurs within a week after operation. Pulmonary infarction, the second type, arrives in the second and third week post-operatively. In massive embolism death usually follows within a few minutes. Should the patient survive, the early chest examination reveals nothing, but within a few hours fine râles are heard. A slight change of the percussion note follows; friction rubs may develop and later increased vocal fremitus and signs of consolidation may be made out. This same course follows in varying degree in infarction. Small infarcts may give no findings even to X-ray.

In any clean post-operative case a low evening temperature is suspicious of thrombosis and significant of possible embolism to follow. Some emboli supposedly from thrombi may be fat after fractures. In his experimental work Dunn (*J. Pathol. and Bacteriol.*, vol. xxvii, p. 425) found fat embolism in the lung of an experimental rabbit following unrecognized fracture of the body of a vertebra.

In the matter of symptoms in non-fatal embolism one has to differentiate between myocardial degeneration and acute cardiac dilatation. Precordial pain, dyspnœa and cyanosis may be the confusing findings, but in the well-examined surgical patient who has been studied before operation, the con-

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dition of, and danger in the myocardium will be known and guarded against.

Strains on the bed pan, efforts to rise from the bed, or to walk, or as in frequent post-partum accident when the woman turns over to assume a knee-chest position early in the puerperium, all give ri·· sudden embolism. Whether this is sudden increase in blood-pressure ʌr tʜe result of suddenly increased pressure locally by surrounding tissues on thrombosed veins is not known.

Source of Emboli.—The common source is not thrombus in the saphenous veins—easily recognized clinically and usually efficiently cared for. The unknown thrombus in the femoral or iliac veins is the common cause. In the jugulars or even the axillary thrombus may lead to embolism. In the five cases which happened to Gordon-Watson within one year (*Practitioner*, vol. cviii, pp. 381–393, June, 1922) one followed a breast amputation where axillary vein thrombosis was suspected, a second after cholecystectomy followed thrombosis of the superior vena cava and after a patella suture there was thrombosis of the internal iliac veins, all three cases being fatal from nine to sixteen days post-operatively. Two other instances, one after an appendectomy and one after thoracotomy for empyema, were not fatal. Massive thrombi must certainly come from the large iliac veins or their branches, as those in the broad ligaments.

In thrombosis of the saphenous vein de Quervain records (*Schweiz. Med. Wchnschr.*, vol. lv, pp. 497–505) an instance where a hernia operation was performed preceded by resection of both saphenous veins for varicosities. Sixteen days after operation the patient died of pulmonary embolism. One may well imagine that the thrombus in this case extended to the iliacs. After radium insertion in the pelvic organs—male or female—thrombosis may extend to the iliac veins by direct continuity as shown in our series. A similar case was reported by Frishmann (*Brit. M. J.*, vol. i, p. 212, January 31, 1925) of a woman of fifty-five years exposed to radium for the cure of epithelioma of the vulva, thrombosis of the iliac vein ensued, followed by pulmonary embolism. Four cases after operation on bones of children were reported by Fickenwirth (*Zentralbl. f. Chir.*, vol. lii, pp. 2821–2824, December 12, 1925). These were all fat emboli, not thrombic. After amputation of septic limbs two instances of embolism were reported by Fischer (*Beitr. z. Klin. Chir.*, cxxiv, pp. 222–229, 1921). These accidents might have been avoided by blocking the vein before taking off the dressings or manipulating the leg. It has long been the writer's practice when amputating the thigh for septic legs to perform a preliminary ligation of the main vessels before the leg is raised or manipulated in any way. Once in a while a femoral vein is found thrombosed up to Poupart's ligament. The application of a tourniquet to such legs may force clots into the venous circulation, expressed by the pressure of the constriction. Even the motions of preparation for amputation may free an embolus.

Pulmonary embolism has followed the injection of bismuth paste. Leb (*Beitr. z. Klin. Chir.*, vol. cxxviii, p. 515) recorded an instance where the

paste was injected into a fistula remaining after an operation for goitre seven weeks before. The fistula was curetted and 10 c.c. of a 30 per cent. bismuth paste were injected. Cyanosis, shallow breathing and a small rapid pulse followed. An X-ray examination showed the bismuth scattered in the lungs. Pleurisy followed; eventually the bismuth shadows became absorbed. Against the possibility of lung emboli originating in the thrombus of the saphenous vein Magnus (*Klin. Wchnschr.*, vol. iii, p. 142, June 22, 1924) finds that the blood stream in this vein is centrifugal when the individual is in the upright position or walking. The peripheral part of the vein remains empty if the central portion is compressed. Lockhart-Mummery (*Brit. M. J.*, vol. ii, pp. 850–857, November 8, 1924) had an instance of dislocation of the hip where the femoral vein was bruised and thrombosis in the iliac vein followed, leading to death from embolism.

Vietor (ANNALS OF SURGERY, vol. lxxxii, pp. 193–198, August, 1925) agrees that most thrombi originate in the femoral and pelvic veins. Many believe that a supine position retards circulation in the leg veins inasmuch as the femoral vein lies close under Poupart's ligament and the iliac veins are compressed by the arterial trunks. Amongst nine autopsies in the New York Hospital on patients dying of pulmonary embolism four had thrombi from the femoral veins, one from the common iliac, one from the inferior vena cava and only one case, carcinoma of the pancreas, had signs of existing phlebitis and thrombosis in the leg. Schilling reported that in 34 cases with a definite phlebitis diagnosed, only one died of pulmonary embolism. Judd and Scholl (*J. A. M. A.*, vol. lxxxii, p. 75, January 12, 1924) cite a case of malignant thrombosis of vena cava caused by the spread of a tumor of the kidney.

Our autopsy records show no known source of this thrombus in three cases, one from the right epigastric vein, two from the right iliac vein, one from the right saphenous vein, three from the left iliac vein, one from the vesico-prostatic flexus and left iliac vein, one from the superior vena cava. In one patient who suffered from carcinoma of the bladder, the right iliac and femoral veins were completely occluded and the thrombus extended up into the lower portion of the inferior vena cava. At the Adelaide Hospital, Cleland and Barlow (*M. J. Australia,* vol. i, pp. 175–176, February 18, 1922) report that 2.5 per cent. of all autopsies showed pulmonary embolism and in every instance the original clots were found in the leg veins.

In his *Surgical Pathology,* Boyd gives the sites from which emboli start as follows:

1. Veins, varicose of leg, inflamed pelvic and uterine, or those about an inflamed appendix.

2. Heart, thrombus formed in the right and left auricular appendix or vegetations on the mitral or aortic valves.

If as Hampton and Wharton believe (*Bull. Johns Hopkins Hospital,* vol. xxxi, p. 35, April, 1920) the primary cause of thrombosis is infection and trauma, while secondary causes are slowing of the blood stream, chemical

and physical changes in the blood and anatomical relations of blood-vessels, how can we explain embolism following perfectly clean abdominal or other operations? Possibly preëxisting or accompanying hemorrhage, as the great blood loss from many patients with uterine fibroids prior to operation, may greatly strengthen the factor of blood change. There is no experimental proof known to the writer which verifies a decrease of coagulation tissue after prolonged hemorrhage.

Thrombus first means a margination and collection of blood plates with leucocytes and fibrin added within a few minutes, but just what causes endothelial changes in the blood-vessel sometimes remote from the operative field is not easily demonstrable. No operation, however, can be done without trauma—or the introduction of some organisms.

In Hampton and Wharton's series after operations on myoma uteri, 69 instances of thrombosis developed; 17 per cent. were anæmic; 24 per cent. had infections of the Fallopian tubes; and many had pelvic congestion with dilated veins and lymphatics. Only one of their patients had thrombosis prior to operation. They concluded that operation seemed to furnish the final condition necessary to thrombus formation. They found 205 instances of thrombosis: 66 per cent. in vessels of the left leg; 24 per cent. in vessels of the right leg; 9 per cent. in vessels of both legs. Very rarely were vessels of the arm, superficial vein of the neck or mesenteric veins involved. The left femoral vein was involved in 40 per cent. of cases. The left saphenous vein was involved in 12 per cent. of cases. The left popliteal vein was involved in 2 per cent. of cases. The pulmonary complications of thrombosis in 205 cases were: 70 per cent. developed pulmonary infarcts and 1.5 per cent. pulmonary emboli, that is, only three patients out of 205 showing clinical signs of thrombosis had pulmonary embolism, only one of which terminated fatally. Eighty-five per cent. of their autopsy examinations after embolism showed the point of origin in the pelvic veins, usually after a symptomless course.

Femoral thrombosis clinically arrives in the second or third week postoperatively, hence its cause may be very different from pelvic thrombosis. It may also be noted that thrombosis of the pelvic veins without operation almost never causes embolism. In embolic accidents after pelvic thrombosis infection is rarely found and one must fall back on a traumatic theory of origin.

In their paper in 1920, Cutler and Hunt lay aside their early study of anæsthesia in relation to post-operative pulmonary complications and accepting embolism as the most important complication, describe the following etiologic factors: Sepsis, easy pathway to the lung and pleural cavity by blood-vessels and lymphatics, hypostasis from confinement to bed, which hypostasis is increased by unconscious (pain) splinting of the abdominal wall through partial inhibition of diaphragmatic movements. Any unexpected or additional movement which does occur, as in coughing, sneezing or deep sighing is liable to set free emboli in the operative field.

Henle (*Verhandl. d. Deutsch. Gesellsch. f. Chir.*, vol. xxx, p. 240, 1901), Gottstein (*Arch. f. Klin. Chir.*, vol. lvii, p. 409, 1893), and Mikulicz report a higher percentage of pulmonary complications with local anæsthesia than with general anæsthesia. Bevan (Trans. Am. Surg. Assoc., vol. xxix, p. 177, 1911; vol. xxxiii, p. 21, 1915). Gatch (*Ibid.*, vol. xxix, p. 196, 1911) and Herb (*J. A. M. A.*, vol. lxvi, p. 1376, April 29, 1916) all believe ether is entirely satisfactory from the standpoint of post-operative pulmonary complications unless definite pre-operative pathology has existed in the lung. Since the advent of ethylene, pulmonary embolism still occurs.

Further statistics shed little light on the subject. Schilling found 32 cases in seventeen years—0.12 per cent. of his operations—11 cases occurring after the use of local anæsthesia. Other reports are those of Wilson (ANNALS OF SURGERY, 1912, vol. lvi, p. 809), Wharton and Pierson (*J. A. M. A.*, vol. cxxix, pp. 1904–1910, December 2, 1922), Shaw (*Arch. Surg.*, vol. ii, 535, May, 1921), Eisendreich (*Monatschr. f. Geburtsh. u. gynäk.*, vol. liii, p. 190, 1920) and Rupp (*Arch. f. Klin. Chir.*, vol. cxv, p. 672) who found emboli or infarcts in the lungs in 5 per cent. of 12,971 cadavers examined in eighteen years. Twenty-two thousand six hundred and eighty-nine operative cases in eighteen years were followed by fatal thromboembolism in 0.26 per cent., while 1.1 per cent. occurred amongst patients with medical diseases who died of this cause.

Treatment for this condition properly resolves itself into prophylaxis and active care in cases of embolism. Prophylaxis concerns:

1. *The Patient Pre-operatively.*—The patient should be put in the best possible physical condition and made the best physiologic risk possible under the circumstances. This includes a careful chest examination by an internist as a part of team work. Known foci of infection, as septic teeth, diseased tonsils or infected sinuses, should be eliminated. At the Presbyterian Hospital we use dental oral prophylaxis on all patients. Digitalis should be given if the pulse is small, the heart muscle weak or the systolic blood-pressure too low. Increase body fluids by blood or salt transfusion or glucose solution before, during and after operation. This is especially valuable in cases where large abdominal tumors are to be removed. Do not starve the patient before operation. Avoid operating on a patient with an existing lung lesion. Possibly morphia pre-operatively may be contra-indicated for its effect on slowing the blood stream.

2. *The Operative Technic.*—Use no constrained position of the patient during operation—with pressure anywhere on the body during operation or any position which promotes venous stasis, especially in the legs. It may be necessary to put a suitable mattress on the operating table, or to have the limbs held in the arms of assistants rather than by mechanical means (Trendelenburg position).

In operative technic reduce all trauma to a minimum, using more sharp than blunt dissection. Employ no rough clamping or packing in of sponges. Harsh and prolonged retraction should not be used. Pressure by retractors

on small branches of the epigastric veins may start thrombosis. Remove all clots from the operative field. Do not use mass ligature. If wounds are septic, drain thoroughly to avoid spread of sepsis and absorption of its products. Avoid chilling of the patient by exposure to cold tables or packs, or widely gaping wounds at operation. Overstretching of the spinal column in gall-bladder operations is to be avoided.

3. *Post-operative Care.*—Do not use anything which promotes venous stasis, such as tight spicas to the hip with pressure on the femoral vein, or too tight heavy abdominal dressings and binder. Keep up the body fluids by means of salt solution, blood or glucose. Use digitalis. Avoid strains in bed—as movements to change position or straining at stool or to change dressings. Oil or other enemata will help avoid strain. Do not stroke or rub thigh or abdomen. Give the patient frequent change of position. Systematic light exercises in bed are beneficial. Any new or unexpected pain in the abdomen or femoral regions should be noted at once and the patient should be requested to make report.

If thrombosis in the leg veins appear, should the vein be ligated? As far as statistics go, the results from frank thrombosis are not frequently fatal. Each case must be judged on its own merits. Probably if showers of emboli were occurring from a known thrombosis, one would be tempted to do a ligation to avoid massive embolism. Consider especially the patient of susceptible age or with lowered vitality.

Active treatment in known massive embolism is too frequently futile. Much depends on the clot size and the part of the pulmonary artery involved. Venesection to relieve the right heart aids. Rapid stimulants as camphor, ammonia, epinephrin or digitalis preparation should be given hypodermatically.

The Trendelenburg operation was advised by the originator because it was felt that often (50 per cent.) only one branch of the pulmonary artery was occluded and removal of the thrombus promptly would revive the patient.

A horizontal incision 10 cm. in length is made over the second left rib, crossing the inner end of the incision by one perpendicular to it, starting just below the sterno-clavicular joint, passing downward to the third rib about one inch outside the left sternal border. The internal mammary artery is dodged—the second rib and its cartilage are cleared out of the way. The cartilage of the third rib is likewise removed and the pleura is opened, over an extent corresponding to the external incision. The pericardium then comes into view; it is opened by an incision inside the passage of the phrenic nerve at the level of the third rib.

By means of Trendelenburg's special sound a rubber tube is passed through the transverse sinus around the ascending aorta to the pulmonary artery. The pulmonary artery is then opened by an incision one-half inch long and the clot is pulled out by means of a special curved forcep. No more than forty-five seconds of time between opening the vessel under pressure

and removing the clot may be consumed—interruption of circulation longer leads to certain death.

Kuschner (*Arch. f. Klin. Chir.*, vol. cxxxiii, pp. 312–359) at the Congress of German Surgical Society in Berlin in April, 1924, presented the first patient cured of pulmonary embolism by Trendelenburg's operation. The patient was a woman thirty years old, who had sustained a massive pulmonary embolism the third day after a femoral herniorrhaphy when she sat up in bed for a lung examination. Fifteen minutes later when she was moribund, the operation was begun. For forty-five seconds the large vessels were closed off during which time after exposure and opening of the pericardial sac the pulmonary artery was opened and blood clots which extended a distance of 17 cm. were removed. Another case recovered after this operation in 1925, reported by Wermbter (*loc. cit.*), but died within a few days from an intercurrent disease.

Only a small amount of experimental work in this subject has been done and the very inviting field lies open. Krampf (*Deutsche. Ztschr. f. Chir.*, vol. clxxxix, pp. 216–240, 1924) gave his results after artificial blocking of branches of the pulmonary arteries by ligatures and by embolism and the effect on the collateral pulmonary circulation. Two other investigations are to be found, one by Binger, Brow and Branch (*J. Clin. Investigation*, vol. i, pp. 155–180, December, 1924) on experimental studies on rapid breathing tachypnœa, dependent on anoxæmia resulting from multiple emboli in the larger branches of the pulmonary artery and in the same volume pages 127–153 on the subject independent of anoxæmia in pulmonary arterioles and capillaries.

POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG*

REPORT OF BRONCHOSCOPIC OBSERVATIONS

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RECENT important contributions have done much in directing the attention of surgeons and internists to Pasteur's original observations regarding massive collapse of the lungs and its occurrence as a post-operative complication.

Numerous clinical and experimental studies have been carried out by many observers and various theories have been advanced to explain the etiology, but no one factor or group of factors seems to satisfactorily account for the production of the atelectasis. Jackson, McCrae, Manges, Pancoast, Bowen and others have made many valuable observations in cases of atelectasis produced by foreign bodies in the bronchi. These cases are the result of a stop-valve obstruction of a bronchus † and the condition can be considered as an obstructive atelectasis.

Whether this mechanism can satisfactorily explain the cases of acute post-operative atelectasis has not been positively established; however, it has been definitely shown by Jackson and Lee † that in one case of massive collapse of the lung the condition was one of obstructive atelectasis. This case was observed bronchoscopically by Dr. Gabriel Tucker, who found mucous plugs obstructing a bronchus. Bronchoscopic removal of these plugs was followed by a marked improvement in the aeration of the involved lung and a rapid recovery of the patient.

The importance of this entire subject and the need for recording all observations made on these cases has led the writers to report their personal observations in the following case:

The patient, a child, aged eight years, was admitted to the Surgical Service of Professor J. Chalmers DaCosta, Jefferson Medical College Hospital, for closure of a gastrostomy fistula.

Six years previously gastrostomy had been performed by Dr. W. P. Hearn when the patient was admitted to the Bronchoscopic Clinic in a serious state of dehydration and starvation, the sequel of extensive lye burns and cicatricial stenosis of the œsophagus. A functional cure had been obtained and now closure of the fistula, which had persisted following removal of the feeding tube, was decided upon.

Preliminary physical examination of the heart and lungs revealed no abnormal findings.

June 10 the gastrostomy fistula was closed by Doctor Hearn, under ether anæsthesia

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* Read before the Philadelphia Academy of Surgery, October 4, 1926.

† Jackson, Chevalier, and Lee, W. Estell: Acute Massive Collapse of the Lungs. Trans. Am. Surg. Assoc., vol. xliii, p. 723, 1925.

administered by the open method. The anæsthetist reported that the patient took the anæsthetic poorly; there was an annoying, short, irritative cough and considerable trouble was experienced with secretions in the mouth and throat.

The post-operative recovery seemed uneventful. About thirty-six hours after operation the temperature gradually rose to 101°, the pulse rate was 130 per minute and the respiratory rate was 48. Examination of the chest by Dr. Norman MacNeill revealed a few coarse râles over the left lower back and axilla. The following morning the temperature was 103.4° and the physical signs suggested a pneumonia involving the left lower lobe. Later examinations by Doctor MacNeill showed an increase in the chest signs and a diagnosis of massive collapse of the left lung was made. Dr. E. H. Funk, who saw the patient in consultation, corroborated the physical findings and concurred in the diagnosis.

Physical Findings.—Patient restless, moderate dyspnœa present. There is practically no cough. Respiratory rate, 50 per minute. Trachea displaced to the left of the median line. Chest flattened on the left side. There is practically no movement of the left chest with respiration. Percussion note dull over the entire left chest to left border of sternum. The entire right chest and the area corresponding to the sternum gave a hyperresonant note on percussion. Breath sounds were practically inaudible over the area of dulness. Apex impulse in 5 I.S. 8 centimetres to left of midline (practically in anterior axillary line). The cardiac impulse was very diffuse extending into the left axilla. The signs suggested collapse of the entire left lung with displacement of the heart and mediastinal structures to the left.

Röntgen-ray studies of the chest made by Dr. W. F. Manges were reported as follows: "There is complete collapse of the entire left lung. The trachea and heart are drawn far to the left. It is impossible to see the outline of the heart or of the left diaphragm. The lung and heart shadows are of equal density so no detail can be seen in the left chest (Fig. 1).

Diagnostic bronchoscopy was decided upon and this was performed 72 hours after operation and about 8 hours after a diagnosis of massive pulmonary collapse was made. This was performed without anæsthesia, general or local. A large quantity of very thick, tenacious, yellow, odorless secretion was found in the trachea and left bronchus. Ten cubic centimetres of secretion were removed with a specimen collector. The mucosa of the left bronchus and its subdivisions was found very inflammatory. The right bronchus seemed normal and was free from secretion. When first observed, the lumen of the left bronchus was completely occluded by the secretion and no air was seen to enter the left lung. The bronchial walls did not move with respiratory movements. Following aspiration of the secretion, the bronchial lumen was seen to dilate and contract with inspiration and expiration.

Immediately after bronchoscopic aspiration, a striking change in the physical signs was observed. There was movement of the left chest with respiration; breath sounds could be heard over the entire left lung; many coarse râles were heard; the cardiac impulse was less diffuse and the apex beat was nearer its normal position. The patient's general condition seemed improved. The temperature remained practically unchanged; however, there was a perceptible decrease in the pulse and respiratory rates.

A Röntgen-ray examination of the chest was made one hour after bronchoscopy. Doctor Manges reported "that the left lung now contains a considerable quantity of air. The trachea is near the median line. The right border of the heart is even with the right border of the spine shadow and the outline of the diaphragm as well as the left border of the heart is clearly seen. There is evidence of lung function, as there is more air in the left lung at inspiration than at expiration. This definitely indicates that some obstruction was removed from the left main bronchus at the time of bronchoscopy" (Fig. 2).

In 18 hours there was a recurrence of all the signs of pulmonary collapse, as

shown by physical examination and radiographic studies (Fig. 3). A second broncho-
scopy was performed 44 hours after the first bronchoscopic aspiration of secretion.
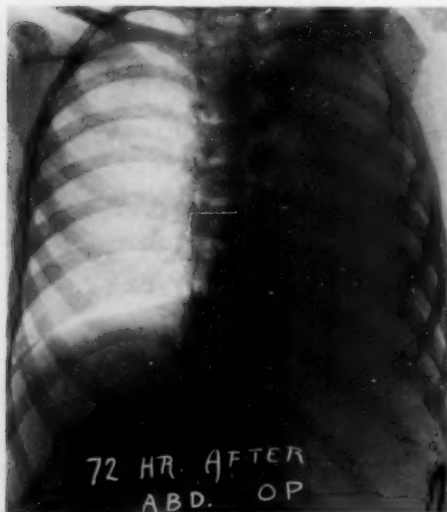
FIG. 1 A. FIG. 1 B.
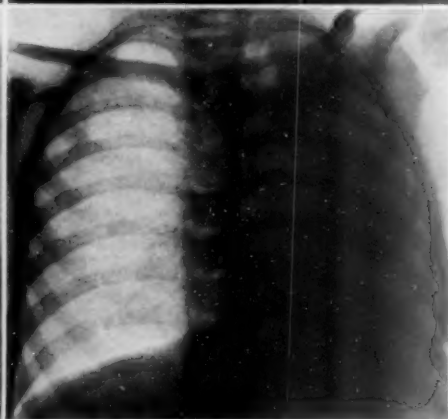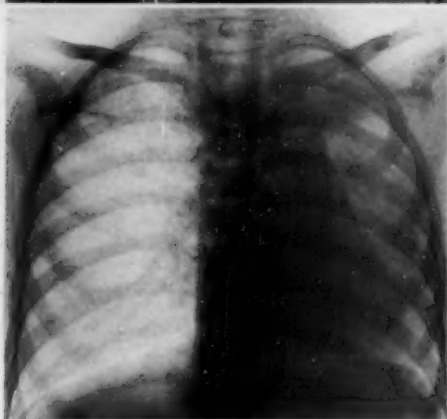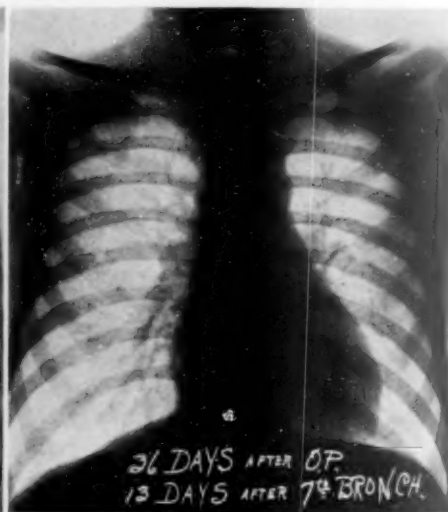
FIG. 2. FIG. 3.

FIG. 1 A.—Röntgenogram, made seventy-two hours after gastrostomy had been performed under
general anæsthesia, shows practically complete collapse of the entire left lung with displacement of the
heart and trachea to the left side of the dorsal spine. The physical signs were typical of pulmonary
atelectasis.

FIG. 1 B.—Röntgenogram, made thirty-six days after the onset of the pulmonary collapse, reveals
a normally aerated left lung. Physical examination revealed no abnormal findings and the patient seemed
well. Bronchoscopic aspiration of thick secretion was performed seven times, the last aspiration having
been done thirteen days before this film was taken. (Film by Dr. W. F. Manges.)

FIG. 2.—Röntgenogram made one hour after the first bronchoscopic aspiration of 10 centimetres of
thick tenacious secretion revealed a striking contrast (see Fig. 1 A). There is a considerable quantity of
air in the left lung, the trachea is nearer the midline, the heart shadow can be clearly outlined and has
returned toward its normal position and the left diaphragm can be clearly seen. By fluoroscopy, function
of the left diaphragm was observed and a change in the air content of the left lung was noted during in-
spiration and expiration. There was no evidence of paralysis of the diaphragm.

FIG. 3.—Röntgenogram made eighteen hours after the first bronchoscopic aspiration of secretion
shows a return of the lung collapse not unlike that observed originally in Fig. 1 A. (Films by Dr. W. F.
Manges.)

The findings were practically identical with those originally observed except that 14
cubic centimetres of thick secretion were removed with the aspirator. Bronchial move-
ments were again observed following removal of the obstructing mucus and air seemed

to freely enter the left lung. This was corroborated by the findings on physical examination.

On the following day there was marked improvement in the patient's general condition, the temperature was 100° and the pulse and respiratory rates showed a marked

FIG. 4 A.   FIG. 4 B.
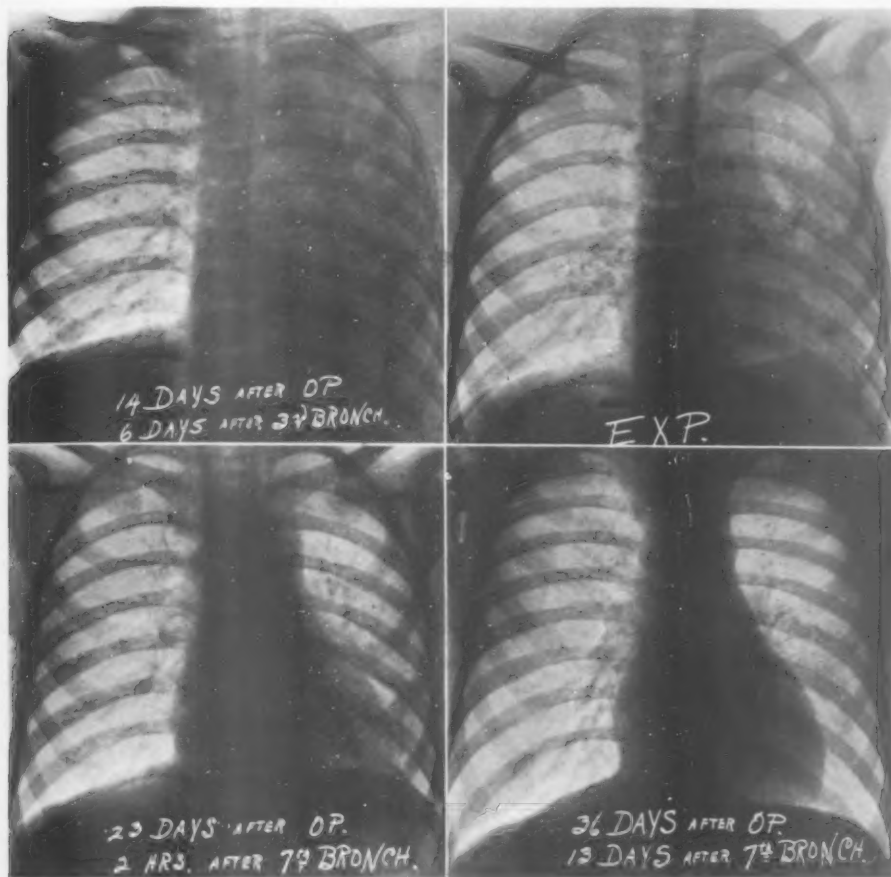
FIG. 5 A.   FIG. 5 B.

FIG. 4 A.—Röntgenogram made on the fourteenth day after operation and six days after the third bronchoscopic aspiration shows increased aeration of the left upper lobe with a persistence of collapse of the left lower lobe.

FIG. 4 B.—Röntgenogram made on the fifteenth day after operation, one and one-half hours after the fourth bronchoscopy, shows striking changes when compared with Fig. 4 A. There is now better aeration of the entire left lung, especially the left lower lobe. The heart and left diaphragm are well outlined and diaphragm function can be observed fluoroscopically. (Films by Dr. J. T. Farrell, Jr.)

FIG. 5 A.—Radiogram made two hours after the seventh and last bronchoscopy on the twenty-third day after gastrostomy. There remains some cloudiness of the left lung field; the heart and mediastinum are practically in their normal position. The left diaphragm is about normal in position and function. At the seventh bronchoscopy but three cubic centimetres of thick secretion were aspirated from the left lower lobe bronchus; the left upper lobe bronchus appeared normal.

FIG. 5 B.—Radiogram made thirteen days after Fig. 5 A. reveals a practically normal appearing chest. Both lungs are clear; the heart is in normal position; both diaphragms function normally. (Films by Dr. J. T. Farrell, Jr.)

decrease; however, the physical signs and Röntgen-ray studies indicated a recurrence of the collapse. Later in the day (sixth day after operation) the temperature rose to 104.2° without any change being observed in the chest findings.

On the eighth day after operation the patient's condition was good, the temperature

being 100.2°; however, there seemed to be an increase in the pulmonary collapse. A third bronchoscopy was done and but 4½ cubic centimetres of secretion were obtained. The endobronchial appearances showed no change over those of previous examinations. There was no increase in the activity of the cough reflex.

Striking improvement in the general appearance of the patient was observed following this bronchoscopy (eighth day after operation), so further aspiration was deferred; however, the physical signs and radiographic findings indicated a recurrence of the collapse. The fever slowly subsided and reached normal on the thirteenth day after operation, but rose the next day to 100°. The physical signs indicated that a very small quantity of air was entering the left upper lobe; the left lower lobe seemed airless. Cough was becoming more active, but seemed to be inadequate to expel the secretion. Bronchoscopy was again done on the fifteenth day after operation. The removal of 4 c.c. of secretion was followed by improvement in the physical signs and Röntgen-ray findings (Fig. 4, A and B).

With the striking changes observed immediately following bronchoscopy and recurrence of the collapse within one or two days, it was decided that more f r e q u e n t bronchoscopic a s p i r a t i o n be resorted to. These were carried out on the seventeenth, the nineteenth, and the twenty-third day after operation. The quantity of secretion removed was 4½, 4 and 3 cubic centimetres, respectively. The secretion became progressively less tenacious and at the two last aspirations it was found only in the lower lobe bronchus, none coming from the upper lobe. The physical signs showed a return of almost complete lung function. The heart remained displaced to the left. The temperature returned to normal. The cough reflex became more active and for the first time the patient was able to cough up and expectorate secretion from the tracheo-bronchial tree.
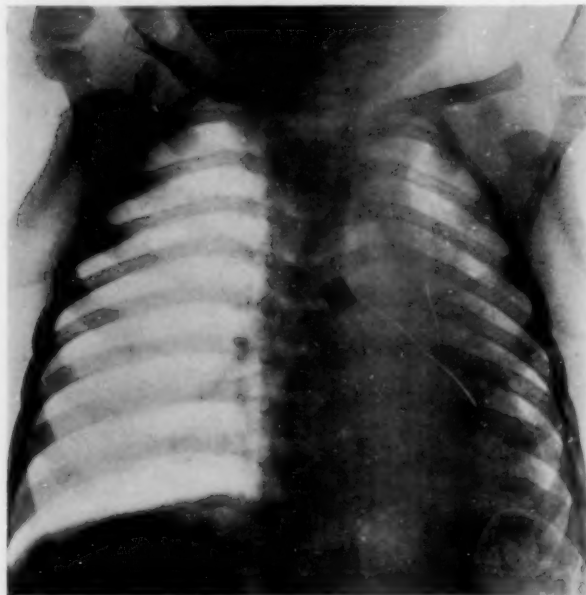
FIG. 6.—Radiogram made in the case of a child, aged three years, eight hours after the accidental aspiration of a portion of pencil with metal cap attached. There was marked atelectasis of the left lung with displacement of the trachea, heart and mediastinal structures to the left. These Röntgen-ray findings were corroborated by physical examination. The foreign body was removed bronchoscopically about nine hours after the accident. A radiogram made twenty hours after removal of the pencil revealed a normally functioning left lung and the mediastinal structures in normal position. (Films by Dr. Leon Solis Cohen.)

A Röntgen-ray study of the chest made two hours after the seventh and last bronchoscopic aspiration was reported by Dr. J. T. Farrell to show that the left lung contained more air than at any time since the onset of the collapse (Fig. 5), and that the exudate had almost completely disappeared. The heart remained slightly displaced to the left side.

Convalescence was uninterrupted and the patient was discharged well July 28, forty-eight days after operation. Physical examination of the chest revealed no abnormal findings. Radiographic examination showed a perfectly aerated left lung. The peribronchial shadows seemed heavier than normal. The heart was in normal position.

Blood Studies.—Examination of the blood was carried out by Dr. I. C. Lintgen. This revealed a moderate leucocytosis which never exceeded 12,000.

Studies of Bronchial Secretion.—Examination of the bronchial secretion was carried out by Dr. B. L. Crawford. The secretion was removed bronchoscopically with the aid of a Lukens' specimen collector and the entire quantity was submitted to the laboratory. It was so thick and tenacious that it remained adherent to the bottom of the collector when this tube was inverted (inside diameter of tube is 2 cm.). Direct smears of the material revealed many pus cells, a large amount of mucus and fibrin and many Gram-positive diplococci. Cultures showed a pneumococcus with an occasional staphylococcus aureus. Subsequent specimen showed the pneumococcus in pure culture.

Comment.—Several factors in this case must be carefully considered in arriving at conclusions regarding the etiology.

It is important to recall, that patients with a stenosis of the œsophagus, sufficient to interfere with the free passage of food and fluid into the stomach often aspirate material into the air passages and an associated chronic laryngotracheobronchitis is a not uncommon finding. Especially is this true in the case of children with œsophageal stenosis. Furthermore, frequent œsophageal manipulations tend to establish tolerance to pharyngeal and probably to laryngeal stimuli. This patient took the anæsthetic poorly and a large quantity of secretion was present in the mouth and throat.

Irrespective of the factors which caused the production of the tenacious secretion and interfered with its expulsion, this secretion undoubtedly produced the pulmonary atelectasis. Bronchoscopy revealed bronchial obstruction with absence of lung function. After removal of the obstruction there was a return of the bronchial movements, and, by physical examination, fluoroscopic observation and radiographic studies, it was conclusively shown that air again entered the lung tissue, the diaphragm resumed its function and the lung expanded. With the recurrence of the bronchial obstruction the lung again collapsed only to resume its function when the obstruction was removed. This observation was made seven times in one case and is supported by evidence secured by physical examination, by Röntgen-ray studies and bronchoscopy.

The bacteriological findings seem to present nothing unusual; however, the physical characteristics of the secretion are of importance. The thick tenacious mucus found in this case was not unlike that observed in several patients presenting asthmatoid symptoms. In these patients the bechic reflex was very active but cough was unproductive. Complete temporary relief was obtained only by bronchoscopic aspiration. This would tend to support the theory that altered secretion of the bronchial epithelium may be an etiological factor.

Collapse of a lung does not immediately occur following complete plugging of a bronchus. Recurrence of all the signs of complete collapse occurred within about twenty-four hours in this case. That collapse does occur quite rapidly was shown in a recent case observed at the Bronchoscopic Clinic. A child, aged three years, choked on a piece of pencil. The patient was observed röntgenologically eight hours after the time of the accident.

Doctor Manges reported the presence of a pencil cap and portion of pencil in the left main bronchus which completely obstructed the bronchus (Fig. 6). There was marked atelectasis of the left lung with but a small quantity of air remaining. The heart was completely displaced into the left chest. A Röntgen-ray examination made twenty hours after the removal of the obstruction revealed the heart in its usual position and the left lung functioning normally.

CONCLUSIONS

Ultimate conclusions cannot be arrived at on the basis of observations made in one case; however, on the observations made in this case it can be stated:

That bronchial obstruction was present, in this case, that the obstruction consisted of thick, tenacious secretion.

That, bronchoscopic removal of the obstruction was followed by a partial return of pulmonary function, and further,

That early bronchoscopic investigation should be carried out in a case of post-operative pulmonary collapse if the surgeon and the internist deem it a safe procedure in the particular case.

MASSIVE HYPERTROPHY OF THE BREASTS*

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In 1891, Dr. C. B. Porter,[1] preliminary to reporting a case of massive hypertrophy of the breasts before the American Surgical Association, said, "I should not think of asking the attention of such a distinguished gathering of surgeons to the report of a single case, were it not that it falls to the lot of but few surgeons to see such a case and still fewer to operate on one." It is, indeed, still rare that the surgeon is asked to amputate the breast solely because it has attained such size, that it is a real burden to the patient, wearying her with its weight, and preventing her from carrying on her usual duties.

Massively hypertrophied breasts are of two types: (1) The fibro-epithelial, and (2) the adipose type. The enlarged breast of the first type consists of fibrous tissue and glandular acini, usually with great preponderance of the former. That of the second type consists mainly of fat with some connective tissue dividing the fat into lobules and containing some atrophied glandular acini.

Of the less than one hundred authentic reports of massive hypertrophy of the breasts, only six † state that the main constituent of the enlarged breast was fat. The rarity of the reports of this form of massive breast-hypertrophy warrants a description of this case.

CASE REPORT.—History: M. R., twenty years of age, colored, entered St. Luke's Hospital, on the service of Dr. S. C. Plummer on March 29, 1926, because of the enormous size of her breasts and the resulting inability to work.

She was always considered as fat, and her breasts were somewhat larger than those of other girls of her age. When fourteen years old, she weighed 148 pounds. At seventeen years of age her menstrual periods began. Soon her breasts began to grow very rapidly, all out of proportion to the rest of her body. She became generally more obese, but the breast-growth continued entirely out of proportion to her obesity. At nineteen she weighed 188 pounds and at entrance to the hospital 240. The breasts were so heavy that for seven months she could do no work and was forced to live on her meagre savings. The sagging of the breasts and friction of her clothes had caused superficial excoriations of the skin of the right breast.

She had a good appetite, ate an unrestricted diet twice daily, felt strong, had no digestive troubles, and slept much. She had dyspnœa, when climbing stairs. This was relieved considerably by supporting the breasts with her hands to lessen the dragging on the chest-wall.

Her menstrual periods began at seventeen years of age, appeared regularly every

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† Guthrie and Albert,[2] Robert and Amusat,[3] Warren,[4] Beatson[5] and Keyser.[6]

twenty-eight days, and continued for three to five days. Several of the last periods were only of two days' duration.

No other member of her family was obese. Her father, however, was "somewhat stout."

Physical Examination.—The patient is an obese negress, about twenty years of age, with enormous breasts (Fig. 1). They both have about the circumference of an ordinary football, hang to a level of more than an inch below the umbilicus, have flattened nipples, and contain no definite nodules or hard masses. There are two superficial irregular ulcers, close to each other and about 3 cm. in diameter, on the front surface of the right breast. The skin about the ulcers is darker brown than elsewhere. There is a very light brown scar of the right breast, in all about 2 cm. square, which resembles the scar from a burn. No other noteworthy deviations from the normal are found upon physical examination.

The basal metabolic rate is 6.5 per cent. below normal. The blood Wassermann reaction is negative. There are 4,350,000 erythrocytes per cubic mm. of blood, and 8950 leucocytes. The hæmoglobin percentage is 85. The urine contains some a l b u m i n, numerous erythrocytes a n d bacteria, and many leucocytes. The systolic blood-pressure is 130, the diastolic 84. The pulse rate is 80, the respiratory rate 24.

Operation.—The breasts were amputated (Plummer) on April 3, 1926, by horizontal, elliptical incisions, leaving two horizontal suture lines. Ether anæsthesia was used. There was very little hemorrhage and no post-operative shock. The left breast, immediately after amputation, weighed 9 pounds and 2 ounces, the right 9 pounds.

FIG. 1.—Massive hypertrophy of the breasts; photograph of case reported by Plummer.

The patient's recovery was rapid and with primary healing of the wound. She was discharged April 15, 1926. Her next menstrual period was very scanty.

Pathological report by Dr. Edwin Hirsch: These two female breasts are about equal in size and weight 9 and 9⅛ pounds. About three-quarters to four-fifths of the outside is covered with a dark brown skin; and in front is a nipple scarcely elevated, 2 cm. in diameter, with an areola 11 cm. in diameter. In the skin of one, 10 cm. from the nipple, are two superficial ulcerations 2.5 cm. in diameter. There is no muscle tissue on the under surface of either breast. On surfaces, made by cutting, practically the entire substance is fat. The amount of fibrous tissue on these surfaces is estimated by three people to be 5 to 10 per cent.

On microscopic sections, portions of the breast contain small ducts and acini, distributed in fibrous tissue septa. Otherwise, there is only fatty areolar tissue.

Discussion.—Deaver and McFarland's [7] monograph on the breast contains 240 references to literature on hypertrophy of the breast. This is not a collection of 240 cases, as some have stated for, as Grieg [8] says, 51 of these articles contain no new case-reports, and another considerable number probably describes breast-enlargements due to tumors.

Grieg,[8] in 1922, could verify only 26 cases of true massive hypertrophy of the breast. The addition of 20 unverified, but probably authentic cases from Deaver and McFarland's list, and the one, reported by him, brought his total to 47.

Thirty-four of these were virgins, five were of doubtful chastity, six were women pregnant for the first time, and two were pregnant multiparous women. The ages of the virgins were eleven to twenty-three years, with nineteen as an average. The average age of those of doubtful chastity was twenty-four; of the primiparous pregnant women, twenty-six, and of the multiparous women, thirty-six. These figures concern mainly the fibro-epithelial type of breast-hypertrophy, for the case of Robert and Amusat [8] was the only adipose type included.

It is evident from the above statistics that hypertrophy of the breast at least that of the fibro-epithelial type, is associated with puberty and with pregnancy, hence, the terms virginal, puberty, puberal, adolescence, gravidity, lactation, and puerperal hypertrophies have been used. Grieg [8] suggests that " puberal hypertrophy " be used to cover the group and includes the rarer variety, appearing with pregnancy, under this term.

When the hypertrophy of the breasts is first apparent, it is thought to be only the development which is normal for puberty or pregnancy, as the case may be. The enlargement, however, is progressive and soon passes physiological limits. The patient and her family are mortified by the great size of the breasts. The awkwardness, brought on by the size of the breasts, and the great weight with the dragging on the chest wall and embarrassment of respiration may quite incapacitate the patient.

The largest breasts were described by Durston [9] in 1669. They were said to have grown to their maximum size over night, following a cessation of menstruation for six months. The left breast weighed 64 pounds and the right 40. This case is probably authentic, except for the period of growth. The spirit of exaggeration on the patient's part, in order to make hers a remarkable case, probably accounts for the statements concerning the sudden appearance of the hypertrophy. Porter [1] described two breasts, which were amputated by him, as weighing 43 and 17 pounds.

Disorders of menstruation, particularly very scanty menstruation and amenorrhœa, according to Grieg [8] and others, often are coincident with over-growth of the breast.

Hypertrophied breasts may be of normal consistency. However, observers have not infrequently described the breasts as soft, except for many fairly distinct nodules throughout. When this nodular character can

be made out, one can feel fairly sure that the hypertrophy is not of the adipose type.

Grieg [8] states that "puberal hypertrophy" is a distinct condition. He does not think that huge, fatty breasts should be included in this category, because general obesity may be accompanied by larger than normal breasts, especially in men. The following table is made with data from the reported cases of adipose hypertrophy of the breast, including the case reported here:

TABLE I

Reporter	Year reported	Age	Menstrual	Puberty	Primipara	Multipara	Wt. of patient	Pain	Growth period	Size of Breast	
										R.	L.
Robert and Amusat[3]	1851	18	Amenor-rhœa	×			....	+	1 yr.	80 cm. circum.	80 cm. circum.
Warren[4]	1905	43	......			2 abortions	....	0	......	....	......
Beatson[5]	1908	30	Amenor-rhœa	..	..	......	196	+	6 yrs.	......	......
Guthrie and Albert[2]	1911	24	Irreg. absent for 3 mos.		×		164	+	7 mos.	5¼ lbs.	4¼ lbs.
Keyser I[6]	1921	19	Scanty	×			178	0	5 yrs.	4.4 lbs.	4.95
Keyser II[6]	1921	41	Normal			×	166	0	1 yr.	5.02	4.07
Author's	1926	20	Late establishment scanty	×			240	0	2 yrs.	9	9⅛
Average	.	28.8	......	3	1	2	188.8	..	2.6 yrs.	5.9	5.72

It is evident from the data of this table that the essentials of the histories of these cases are much like those in which the breasts consisted mainly of fibro-epithelial tissue. The average age for the unmarried patients is nineteen, the same as that for the virgins of Grieg's collection. The age of the woman, pregnant for the first time, is twenty-four, while Grieg's average is twenty-six. The ages of the two multiparous pregnant women averaged forty-two. Grieg's average is thirty-six.

In five of the six reports of the table, which mentioned the menstrual function, a distinct departure from normal menstruation was described, with the tendency towards amenorrhœa. This also is in agreement with the statement of Grieg concerning the fibro-epithelial type.

The breasts of obese women may be singularly small, or they may be large, quite in proportion to the obesity of the body as a whole. The massively hypertrophied breasts of the adipose type not only develop at times and under conditions quite analogous to the fibro-epithelial type, but also have a structure which is not that of the breast of obesity. Guthrie and Albert [2] pointed out that the large breasts of general obesity, although con-

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taining large amounts of fat, have a real glandular portion, well circumscribed and quite free from fat, while the hypertrophic breast of the adipose type has the glandular portion disseminated in the connective tissue which divides the fat into lobules.

Huge hypertrophy of the breast, occurring at puberty or pregnancy with a not infrequent menstrual abnormality, suggests that some constitutional disturbance, possibly of endocrine nature, is the inciting factor. Williams [10] states that the normal increase of the female breast at puberty may often be due " even more to the overgrowth of its fibro-fatty envelope than to the glandular ectasia." It seems plausible that a constitutional or endocrine derangement, which causes great hypertrophy of the mammary fibro-epithelial tissue in the average non-obese young woman, may cause a marked hypertrophy of the fatty areolar tissue in individuals who are prone to deposit fat. The two types of hypertrophy have an important point in common. In both the hypertrophy is diffuse with dissemination of the acini. The main difference between the fibro-epithelial and adipose varieties is that in the former the tissue is usually mostly fibrous and in the latter mostly fat with a meshwork of fibrous tissue.

Inasmuch as these two forms of breast-hypertrophy cause truly massive breasts, and inasmuch as they, after all, are probably not so distinctly related, it seems logical that the term, massive hypertrophy of the breast, be applied as a descriptive term to include hypertrophies of both types, as was suggested by Keyser.[6]

Grieg [8] accepted only eight cases of enlargement of the breasts accompanying pregnancy as belonging to this group. Von Angerer [11] says that the large breasts of pregnancy and those of puberty are differentiated by their course. The former are greatly reduced by abortion, confinement and by medical treatment. The latter do not respond to these measures.

It is noteworthy that most of the various reports of spontaneous resolution, or of resolution following the administration of iodides and tight bandaging, concern the enlargement of the breasts with pregnancy. Monod [12] saw a patient whose breasts became very large with each of three pregnancies, but returned to normal size after each confinement. Rosinski [13] tells of a twenty-eight-year-old woman who was at the sixth month of pregnancy and had colossal breasts. With each of three preceding pregnancies there was great enlargement with ultimate resolution. Esterle [14] states that the huge breasts of a pregnant girl of twenty years diminished to normal size after confinement and copious secretion of milk. One wonders if these were truly cases of the massive hypertrophy under discussion, especially since the latter are rarely reported as functionating breasts.

The report of spontaneous resolution of hypertrophied breasts by Benoit and Monteils [15] illustrates the lack of function of these breasts and the time necessary for resolution. The breasts of their patient began to enlarge when she was fourteen and a half years old and continued to grow until she was eighteen. They remained about the same size for eight years and then, after

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the birth of three children, atrophied until the skin hung in loose folds. No milk was secreted at any time.

The treatment of massive hypertrophy of the breasts is apparent from the foregoing statements. The term, massive hypertrophy of the breasts, entails huge breasts, frequently of such size that invalidism is the patient's lot. When this enormous growth occurs at puberty, without the influence of pregnancy, amputation is the only treatment. The importance of the organs to be removed is no contra-indication to amputation, for seldom do these breasts functionate.

When pregnancy is seemingly the factor inciting the enlargement of the breasts, it is best to wait and watch. It is most difficult or impossible to distinguish the excessive physiologic-like growth of the breasts in pregnancy from the hypertrophied breasts, similar to those of puberty. The former, usually become normal or much reduced in size after parturition.

Fitzwilliams [16] and Rovsing [17] tried X-ray therapy without marked success. One of the breasts of Rovsing's patient, however, did decrease in size.

SUMMARY

A case of massive hypertrophy of the breasts of the adipose type is described. It is logical that this type be included with the fibro-epithelial type under the term massive hypertrophy of the breasts.

This affection, occurring at puberty, warrants amputation. When it occurs with pregnancy, operation should be delayed until it is evident that resolution does not follow the termination of pregnancy.

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CONGENITAL HYPERTROPHIC PYLORIC STENOSIS*

A STUDY BASED ON 48 PERSONAL CASES

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THE pylorus of the normal infant is a soft, pliable structure, the gastric and duodenal extremities being readily approximated by compression between the thumb and index finger. The pyloric circular muscle up to three months of age measures not more than 2.5 mm. (Fig. 1.)

In congenital hypertrophic pyloric stenosis (Fig. 2) the pyloric region is occupied by a sharply defined tumor mass of unknown etiology, measuring from seven-eighths to an inch and a quarter in length and from five-eighths to six-eighths of an inch in diameter. It is of a firm, nearly cartilaginous consistency, covered with smooth, glistening peritoneum free from adhe-

FIG. 1.—Cross-section of normal pylorus, magnified five times.

sions and having a whitish, pale color as compared with the remaining portions of the stomach and duodenum. Pathologically this tumor consists of a massive hypertrophy of the circular musculature of the pylorus, the hypertrophied circular muscle measuring from 3 to 7 mm. in thickness up to three months of age. As a result of this tumor formation the pyloric canal becomes stenosed and greatly lengthened, constituting a mechanical interference and obstruction to the outlet of the stomach. The lesion has been observed in a seven months' fœtus, and on a number of occasions in the still-born, and would, therefore, seem to be developmental, thus justifying the term " congenital." In a few instances, the condition has been observed in twins.

In addition to the pyloric hypertrophy, examination in some cases has shown a definite hypertrophy of the musculature of the stomach and lower portion of the œsopha-

FIG. 2.—Cross-section of pylorus in case of hypertrophied pyloric stenosis, magnified five times.

gus. Gastric dilatation with atony and gastritis develop secondary to the obstruction in the neglected cases. In the presence of these pathological

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* Read before the Western Surgical Association, October 14, 1926.

findings a striking clinical picture is presented, of explosive, projectile vomiting after each meal accompanied by isoperistaltic waves. As a result of the obstruction and vomiting the stools become absent or meconium-like, consisting of bile and mucus; the urine becomes scanty; dehydration and acidosis develop and there is a rapid, progressive loss of weight. These little patients shrivel up and the skin becomes dry and inelastic. Palpation of the abdomen is usually negative. Increase of tonic or clonic spasm of the abdominal musculature is absent. I have been unable to palpate the tumor mass, and when it is recalled that the liver of the normal infant occupies two-fifths of the abdominal cavity, quite completely covering the stomach, we can readily understand why the tumor is not felt. This in spite of the common statement to the contrary, recalling the time when the chronically inflamed appendix was reported as being frequently palpated. Even with the abdomen open the pyloric tumor is only palpable by hooking the finger up under the liver.

Fig. 3.—*Rammstedt Operation: Illustration a*, showing longitudinal incision through the pyloric tumor mass. The hypertrophied circular muscles have been divided and spread, showing the liberated mucosa of the pyloric canal below. *Illustration b*. Omental flap sutured over the Rammstedt incision to prevent objectional adhesions to the liver or other nearby structures.

The Röntgen-ray examination has not been found helpful nor necessary, the clinical picture being so clear and reliable. In fact, the Röntgen-ray study may be misleading in that the metallic, opaque substance used may pass quite readily through a pylorus which obstructs the passage of food.

The condition occurs most frequently in the male, there being only two female infants in the series of 48 cases. The majority were seemingly normal, well-developed infants at birth and were breast-fed, the symptoms beginning at the end of the second week and becoming alarming about the third week. Cases were referred to the pædiatrician most frequently about the fourth or fifth week. Usually a week is spent under pediatric management, after which time, with continuance of symptoms, weight loss or no gain, the child is prepared for operation.

These cases are never so emergent as to require immediate operation.

Adequate pre-operative preparation is absolutely essential to success, and the more advanced and neglected the case the more important becomes the

need of this preparation. At least from twelve to twenty-four hours is well spent in overcoming the dehydration and acidosis. Gastric lavage should be done, continuance of feeding efforts, and, most important, water should be given under the skin and per rectum. Intraperitoneal injection has been tried, and while no ill effects followed, I consider the intraperitoneal reaction, as evidenced by turbid, flaky fluid, to be undesirable.

There is no field of surgical endeavor in which intimate coöperation between the physician and the surgeon is more imperative than in the surgery of infancy. The success achieved in this series of cases has been in a large measure due to the sharing of the responsibility for the patient while in the operating r o o m and to the skilful p r e-o p e r a t i v e and post-operative care b y t h e pædiatrician.

Various t y p e s o f operations h a v e b e e n practiced in the surgical treatment of this condition, including pyloro-plasty and pylorectomy, with resulting prohibitive mortality. Devulsion of the pylorus by the introduction of dilators

FIG. 4.—Diagram illustrating division of pyloric circular muscles, as in cutting of a ring, leaving the muscles without origin or insertion. The circular muscles retract and undergo disuse atrophy with permanent disappearance of the pyloric tumor mass.

through a gastrotomy, while not so dangerous, does not, in the majority of cases, give the desired relief. Gastro-enterostomy, both anterior and posterior, while giving a satisfactory result in the successful cases, is technically extremely difficult and attended by too high a mortality. While the obstruction is overcome by the short-circuiting, the pyloric tumor mass remains intact and unchanged for a number of years, as observed by subsequent laparotomies, autopsies and by Röntgen-ray examinations showing all of the barium passing through the gastro-enterostomy.

The Rammstedt operation, in which a longitudinal incision is made through the tumor mass down to the mucosa with spreading, has become the standard and safest procedure. Its results are not alone successful but the operation is curative. (The longitudinal incision through the pylorus produces the transverse division of the circular muscle as in the cutting of a ring and leaves the muscles without an origin or insertion. As a result, the circular muscles retract and undergo disuse atrophy) with permanent
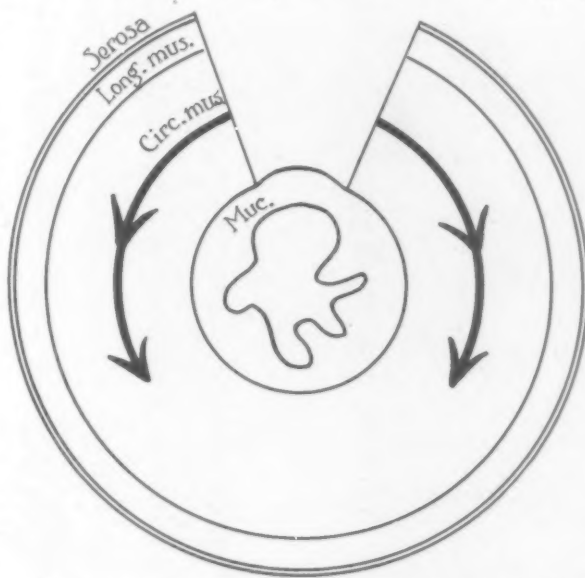
disappearance of the pyloric tumor mass. The encroaching on the pyloric canal by the infolding of the mucosa is immediately relieved.

In my series of 48 cases two gastro-enterostomies and forty six Rammstedt operations were performed with the loss of one infant. The duodenal mucosa was accidentally opened in two cases, as made evident by the presence of small bile-stained bubbles. A single stitch in each instance closed the opening and the accident in no way affected the convalescence of the patient. Forty-six of these patients were males.

The operation is performed through a short, high, upper right rectus or perimedial incision just long enough to permit of the deliverance of the pyloric tumor and so short as to prevent any other evisceration. In the ideally performed operation not a single loop of bowel should protrude or even be seen at any time. An incision an inch and a half long usually suffices, and two inches is the maximum length. Unnecessary evisceration is time-consuming, involves exposure and as a result of the manipulation necessary for reduction inflicts a type of shock illy borne by infants. The pyloric tumor is delivered into the wound, and a longitudinal incision is made through an avascular region down to and exposing the pearly white mucosa, which is well liberated by spreading the margins of the wound with a curved Carmault hæmostat. Scrupulous attention is paid to hæmostasis and all bleeders are sutured. A free portion of the omentum is sutured to the upper margin of the region to prevent adhesions of this area to the liver or other structures, such an occurrence having produced post-operative obstruction with death. The pylorus is returned to the peritoneal cavity and the wound closed in layers.

Fig. 5a—Braided silk stay sutures impregnated with wax, tied over buttons. Due to the impaired healing qualities of these emaciated infants, thorough support of the wound is necessary.

The operation (Figs. 3, 4 and 5) should be rapidly and delicately performed with minimal traumatization. The shortest time from skin incision to skin closure was ten minutes, and the second half of the series averaged from twelve to fourteen minutes. The following factors as employed, while seemingly of minor importance are, in my opinion, major considerations and essential in achieving the highest degree of success. The operating room should be warm and free from drafts. In this series the operating room temperature has been maintained at 80° F. and higher. Most of these emaciated infants weighed less than at birth, the body weight being as low as four and a half pounds. The child's extremities and body, with the excep-

tion of the operative field, are bandaged in cotton batting and surrounded by hot water bottles. A trained surgical team is indispensable to smooth and rapid work. Ether, administered by a skilful anæsthetist familiar with the requirements of pædiatric surgery, has been the anæsthetic of choice, and has been employed except in two cases which were done under local anæsthesia. Under local anæsthesia the straining of the infant forces loops of bowel through the wound, thus producing the shock factors and time loss referred to above. The surgical team are scrubbed before the anæsthetic is com-

menced, and the first min-
ute in w h i c h surgical
anæsthesia and complete
relaxation are obtained the
operation is started. In
other words, the surgeon
waits for the patient, and
not the patient for the
surgeon. It is my opinion
that operations performed
under general anæsthesia
are too frequently begun
before the patient is prop-
erly relaxed. The stimu-
lation of the too early
incision results in a greater
quantity of ether being
required and is followed
by straining, varying de-
grees of evisceration,
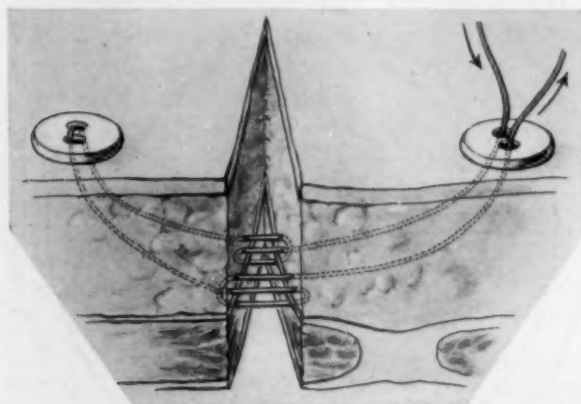which require manipula-
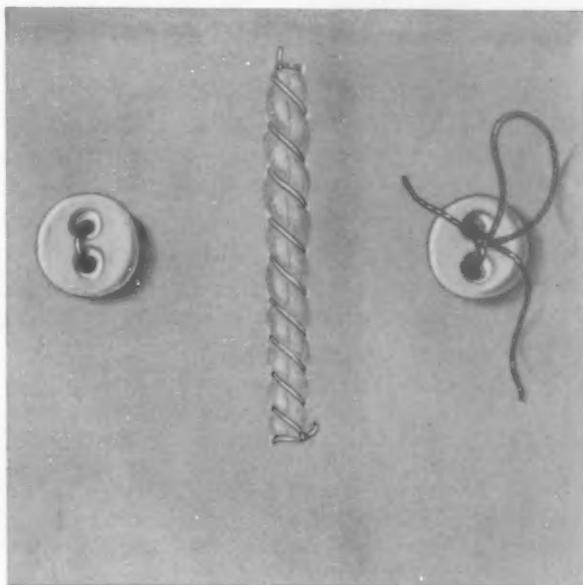
Fig. 5b.—Braided silk stay sutures impregnated with wax tied over buttons. Due to the impaired healing qualities of these emaciated infants, thorough support of the wound is necessary.

tion and packing, all of which result in trauma, which is shock producing, and may result in the development of post-operative adhesions. All abdominal packs and sponges are wrung out of normal saline, maintained at 110° F. by thermometer reading in the solution, thus avoiding the shock produced by either too hot or too cold temperatures and likewise preventing injury to the peritoneum which results in the formation of adhesions.

Infants do not withstand the loss of blood, even in small amounts. Hemorrhage in these little ones is synonymous with shock. Strict attention is paid to hæmostasis.

On completion of the operation the child is wrapped in warm blankets and returned to its crib, which has been warmed with hot water bottles, the temperature of the water being 110° F., as ascertained by thermometer read-ing. Feedings are begun in three to four hours after the operation. No transfusions were done in this series of cases. The pædiatrician has directed practically all of the post-operative care except the care of the wound. A

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specially trained and experienced pædiatric nurse is valuable during the post-operative and convalescent period.

Louis W. Sauer, in the *Archives of Pædriatics*, March, 1924, reviews 761 cases in which the Rammstedt operation was performed with 91 operative deaths, or a mortality of 12 per cent.

The following operative results are quoted from an article by W. F. Fowler, ANNALS OF SURGERY, December, 1925: " Poynton and Higgins report 20 cases treated during 1920 and 1921 with an operative mortality of just under 45 per cent. The surgical mortality for the 35 patients treated during 1922 and 1923, however, was less than 15 per cent. The improvement was due to earlier operations. Mixter reports 195 operations during the past ten years with a mortality of 9.5 per cent. Strauss, in 1920, reported 103 operations with three deaths. Palmer, in 1922, reported 39 operations with two deaths. Porter, in 1919, reported 22 operations with two deaths. Hill, in 1920, reporter 22 operations with one death."

Rodda, in a review of the subject, reported 12 cases treated medically with a mortality of 36 per cent. as compared with 17 cases treated surgically with a 5.8 per cent. mortality.

In my series of 48 cases there was one death, or a mortality of 2 per cent.

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DUODENAL DIVERTICULITIS

SECOND REPORT

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My reasons for again calling attention to the subject of duodenal diverticulitis are:

I. Further experience shows that the condition though rare occurs more frequently than was at first supposed.

II. There are no characteristic symptoms from which a diagnosis can be made clinically.

III. No technic for the removal of a diverticulum imbedded in the head of the pancreas or in the retroperitoneal space is described in text-books on operative surgery.

I. *Occurrence.*—Since discussing the subject of duodenal diverticulitis at the meeting of this Association in 1922, J. C. B. Grant, Professor of Anatomy in the Medical Department of the University of Manitoba injected with paraffin the duodeni of all cadavers brought to the dissecting room. With surprising regularity he found diverticula present in two out of every twelve specimens examined. In three years thirty-seven bodies were examined and in six, diverticula of the duodenum were present, an average of 16.2 per cent. Baldwin in a series of 105 necropsies found 14, or 13.3 per cent.

It would appear from the foregoing statistics that in the routine röntgenological examination of the gastro-intestinal tract that a large percentage of diverticula are not visualized or are missed by the röntgenologist. Case's statistics show that diverticula of the duodenum are demonstrated in 1.2 per cent. of all barium meal examinations. J. C. McMillan, radiologist to the Winnipeg General Hospital, found 10 in 653, or 1.5 in every hundred cases. This wide discrepancy between the anatomical and X-ray statistics must be emphasized. In spite of the modern improvements in X-ray technic, it is only 10 per cent. efficient in the diagnosis of this very important lesion of the upper abdomen.

II. *Diagnosis.*—There are no symptoms characteristic of the condition from which a diagnosis can be made clinically. The symptoms simulate those of gastric, as well as extragastric lesions causing gastric symptoms. It is another condition entering into the problem of the " chronic abdomen."

The diagnosis is made by keeping the condition in mind, by a process of elimination and by the aid of the X-ray. The ratio of diverticulitis to diverticulosis must be considered. It has been estimated at 2 in 10, I believe it is higher for cases demonstrated by the X-ray. It is not enough that a pouch

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* Read before the Western Surgical Association, October 14, 1926.

holding barium is demonstrated, the röntgenologist should go further and determine if possible to which part of the duodenum the diverticulum is attached. The operating surgeon will find that having this exact knowledge beforehand he may yet have the greatest difficulty in locating the pouch, when imbedded in the pancreas or placed posterior to it. Stereo-röntgenograms will aid in determining the relationship of the diverticulum to other structures.

With the abdomen opened the presence of peridiverticulitis will confirm or make the diagnosis, and is a guide to localization of the lesion. Peri-
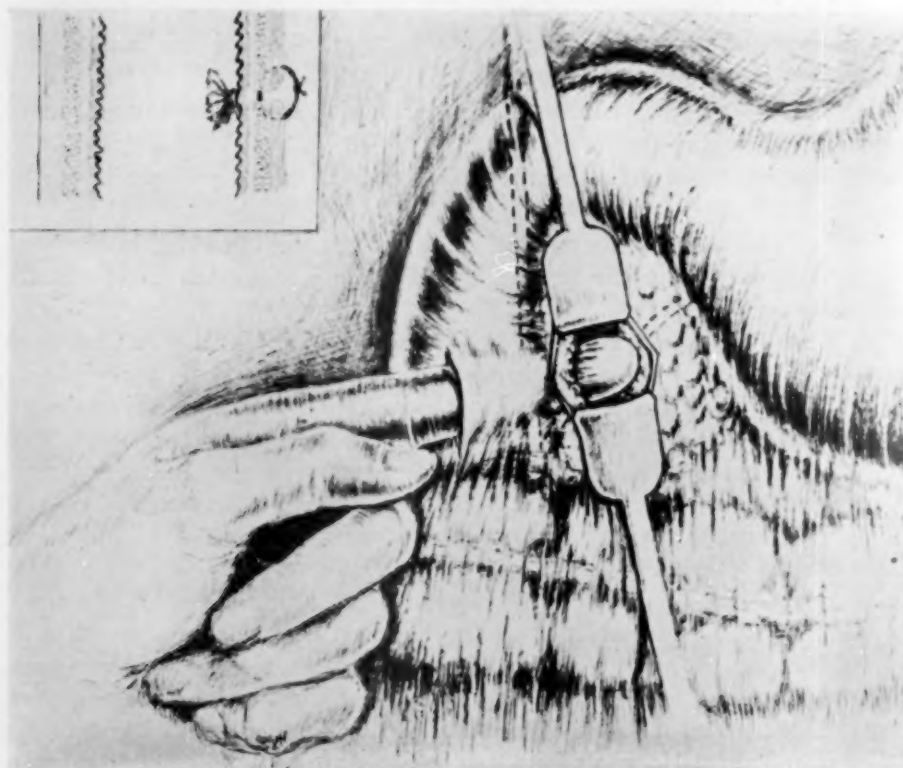
FIG. 1.—Transduodenal diverticulectomy.

diverticulitis was strikingly evident in two of my four cases operated on. Both were retroperitoneal. In my last case, however, periduodenitis was the outstanding feature and was in my opinion directly due to the inflamed diverticulum in the retroperitoneal cellular tissue.

My experience has been limited to sixteen cases. In all, the presence of a diverticulum was demonstrated with the X-ray and in none was the diagnosis made clinically. There were four cases of diverticulosis, the symptoms being entirely accounted for by other abdominal lesions. Eight had symptoms presumably due to diverticulitis (*i.e.*, no other cause for their symptoms could be found), but not sufficiently severe to advise surgery. Four cases had extremely severe symptoms and were operated on. Three were entirely relieved of their symptoms. The other was done too recently to be able

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to report on the end result, though the patient is making a favorable convalescence.

III. *Operative Technic.*—1. Diverticula on the anterior peritonealized surface of the duodenum.

2. Diverticula imbedded in the pancreas.

3. Diverticula behind the pancreas, or in the retroperitoneal space.

Diverticula on the anterior, peritonealized surface of the duodenum offer no surgical problems. They are covered with peritoneum and their removal is simple. If pedunculated they may be ligated at the base, the stump carbolized and b u r i e d with a purse-string suture. It is well to anchor a corner of the great omentum over the place for greater security. If sessile or wide at the base, excision or simple inversion with Lembert sutures placed so that the suture line is transverse to the long axis of the duodenum will suffice.
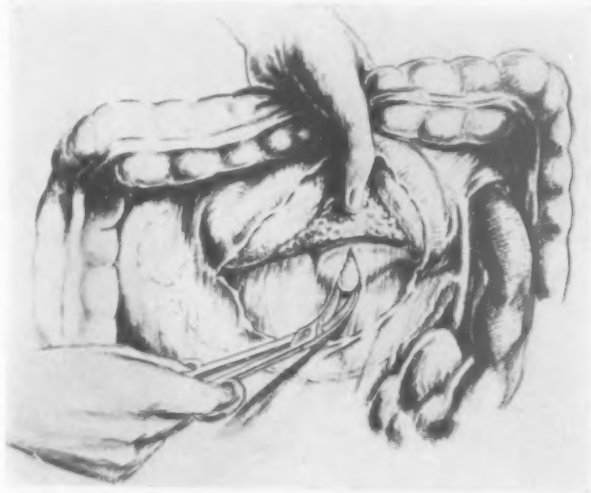
FIG. 2.—Mobilization of third part of the duodenum and removal of diverticulum attached to fourth part.

A diverticulum imbedded in the head of the pancreas or behind it in the retroperitoneal tissue presents much greater difficulties. The radiologist may tell us from which part of the duodenum it originates, but cannot tell us whether or not it is imbedded in pancreatic tissue. In my first case I got the clue from the pancreas being greatly thickened and indurated. The method of removal is shown in Fig. 1, and is described in my former article, *Surg., Gynec. and Obst.,* July, 1903.

A diverticulum behind the pancreas in the retroperitoneal cellular tissue will require mobilization of the duodenum and head of the pancreas for its removal. If attached to the first or second parts, mobilization after dividing the parietal peritoneum along the right border of the duodenum, reëstablishing the embryological condition before rotation had taken place, will expose the posterior surface of the duodenum and head of the pancreas. This method of mobilization of the duodenum is used in other operations such as, the Phinny operation of pyloroplasty and in duodeno-choledochotomy.

Diverticula attached to the third and fourth part of the duodenum and behind the pancreas may be removed by a method which I used and which I have not seen described. The transverse colon with its mesocolon and great omentum are turned upwards, exposing that part of the duodenum (third part) below the attachment of the transverse mesocolon. The posterior

parietal peritoneum is incised along its lower border, the right colic artery being avoided. The superior mesenteric vessels are drawn to the left. This exposes the posterior surface of the third and fourth parts of the duodenum and the posterior surface of the head of the pancreas. (Fig. 2.) In the case here recorded, the diverticulum was with some difficulty found imbedded in the cellular tissue behind the pancreas.

While there is no question about the inadvisability of drainage in an intraperitoneal operation, removal of a diverticulum from the retroperitoneal cellular space with tissue so vulnerable to the slightest infection calls for at least a temporary drain.

CASE I.—W. W. F., female, age forty-four, October 15, 1925.

Primary Complaint.—1. Stomach trouble—twenty years. 2. Gaseous eructations. 3. Nausea and vomiting. 4. Loss of weight —thirty-five pounds in twelve months.

Previous History.—1. Infectious fevers in childhood. 2. Operation, 1923. Appendectomy and salpingectomy.

Present Illness.—Began twenty years ago with attacks of nausea and vomiting, lasting about one week. These spells would recur two or three times a year. No change occurred until about
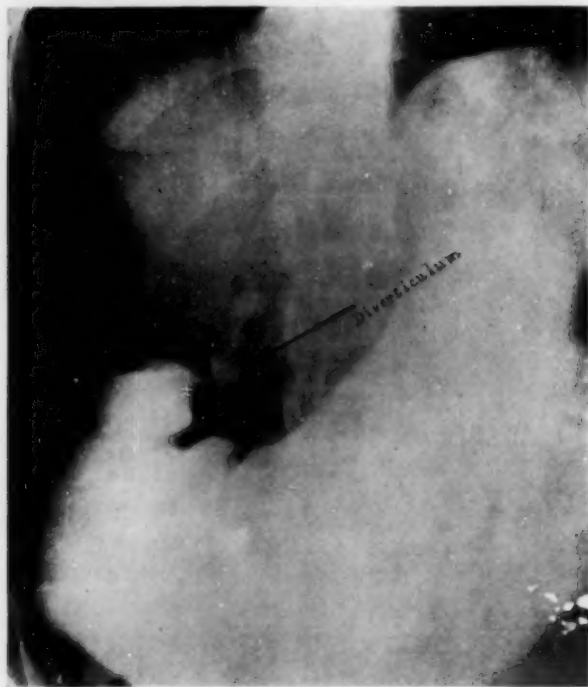
FIG. 3.—Diverticulum attached to first part of duodenum associated with pyloric obstruction.

April, 1925, when she had a particularly prolonged spell and since then the attacks have been very frequent. Attacks usually came on at night, which were partly relieved by taking soda and vomiting. No abdominal pain at any time. The first attack occurred at eighteen years of age. Vomitus was "coffee ground" in appearance. Stool was black. No dark vomitus or melena since. Lately has been vomiting large quantities, as much as two quarts. During first few years attacks associated with some diarrhœa.

Appetite fairly good. Belches a great deal of gas between attacks. Has lost thirty-five pounds in weight during past twelve months. Stomach is upset when she becomes excited. This has led to a diagnosis of nervous dyspepsia. No urinary symptoms. No pulmonary or cardiac symptoms. Menses normal and regular. No pregnancies.

Examination.—No apparent oral or nasopharyngeal sepsis. No enlarged supraclavicular glands. *Abdomen:* Fulness in epigastrium. No tenderness. Supra-pubic scar. No mass. *Pelvic:* Negative. *Rectal:* Negative. *Heart and lungs:* Negative. *Pulse:* 74. *Blood-pressure:* 120/86. *Gastric Analysis:* Free HCl, 68; total, 118. *Urinalysis:* 1032, clear ambre acid. Sugar and albumin negative. Micro., negative. *X-ray:* The stomach is very large, possibly three times its normal size. The pylorus is cut off, and

the first part of the duodenum is poorly filled. There is a gastric residue at the end of twenty-four hours. This would indicate a pyloric obstruction, possibly due to ulcer. A diverticulum is seen attached to the first part of the duodenum. (Fig. 3.)

Operation, October 26, 1925.—1. Posterior gastro-enterostomy. 2. Invagination and purse-stringing duodenal diverticulum.

Notes.—Stomach was very large. Gall-bladder was negative. There was a duodenal pouch, size of a walnut, on the anterior surface of the duodenum immediately beyond pyloric ring. There was some thickening and induration of the duodenum at the base of the diverticulum. Pylorus was thickened. No u l c e r could be demonstrated.

CASE II.—Diverticulum imbedded in head of pancreas. History and operation fully described in *Surgery, Gynec. and Obst.*, July, 1923.

CASE III.—M. M., male, age thirty-seven, occupation farmer, January 26, 1925.

Family History.—Father died aged sixty-four (paralysis), mother living and one sister.

Marital History.—Marriage age twenty-three—six children living and healthy.

Previous Diseases and Injuries.—Pneumonia, grippe, tonsillitis.

C h i e f Complaints.—1. Stomach trouble. 2. Pain in epigastrium, referred through to back. 3. Constipation. 4. Loss of weight.

General Description of Patient.—Rather undernourished.

Clinical History.—About three years ago he began to

FIG. 4.—Diverticulum of duodenum attached to fourth part.

have pains in the epigastrium, but these did not trouble him much for a year. They have gradually been getting worse and lately have been so severe that he has been unable to do his work properly. The pain comes on about five minutes after eating and is referred through to the back. Not up to the right shoulder. Lately it has been so bad that he has been unable to sleep at night. Years ago he vomited occasionally but has not lately. When hungry he gets dizzy and weak and can hardly see anyone. Is constipated and always has to take medicine for the bowels. No other complaints.

Patient states that he is often afraid to eat even when hungry on account of pain in the stomach five or ten minutes after eating. For the last year he has not been able to work hard because the pain is severe then. He feels dull and drowsy and finds it very difficult to get up in the morning as he feels tired and aches all over.

Physical Findings.—Tonsils small but ragged. Infection—no pus could be expressed. Tenderness over duodenum. Slightly tender over appendix.

Urinalysis.—January 27, 1021; albumin; sugar negative. January 30, 1016; albumin faint trace; sugar negative.

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Test Meal.—Total acidity 42; HCl 12; combined HCl 30. Food remnants not free until one and a half hours.

X-ray Report.—Stomach and duodenum negative. Duodenal diverticulum shown.

X-ray Report and Examination of Stomach.—Fluoroscopic examination showed no six-hour retention in the stomach, though there was some barium which appeared to be either in the duodenal cap or in a diverticulum, the rest of the small bowel was empty. The appendix was plainly visible and appeared long and rather evenly filled. On examination the stomach outline appeared regular, peristalsis normal, and showed no filling defect. Stomach negative. The duodenal cap was also seen to fill to the right of and to be separate from the barium previously noted. As the cap emptied, the course of the duodenum could be traced and the ascending portion was seen to be more to the right than usual and to ascend higher than normal and just after this turned to the left the barium was seen to flow into a diverticulum, which hung downward and to the right. This diverticulum could be about half emptied by pressure. It appeared to be one inch and a half in length and to have a wide base. (Fig. 4.)

The plate taken twenty-four hours later showed the diverticulum about half filled with an air bubble filling in the fundus. (Fig. 5.)

A forty-eight-hour plate showed the diverticulum emptied. The barium was still seen in a very low and narrow transverse colon.
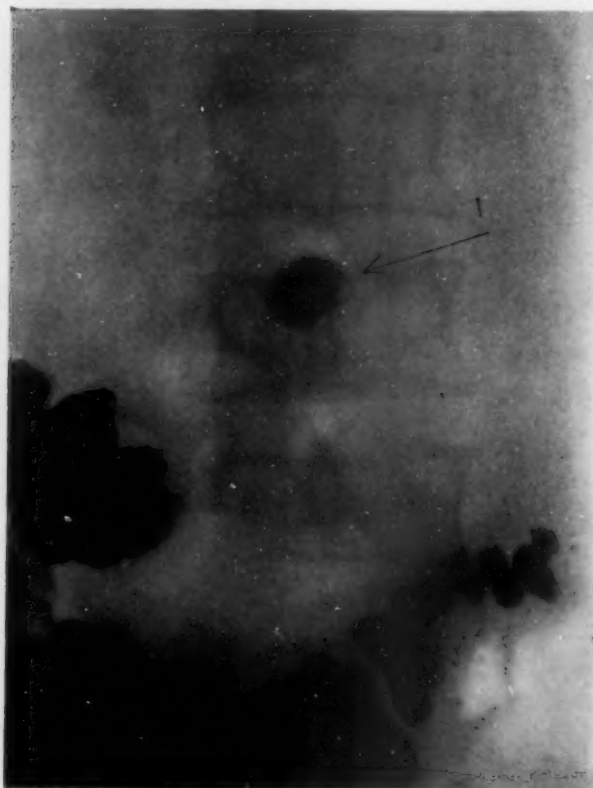
FIG. 5.—Barium and air bubbles in diverticulum attached to fourth part of duodenum. Twenty-four-hour plate.

Operation.—Right transverse incision above umbilicus. To get more room it was continued upward midline vertical for two or three inches (Perthes' incision), exposing stomach, duodenum (first and second parts) and gall-bladder. No pathology could be seen. Turning up the great omentum, transverse colon, and mesocolon showed these strictures adherent to the posterior parietal peritoneum, especially that covering the third and fourth parts of the duodenum and right side of the mesentery. Those structures to the left of the superior mesenteric vessels were free from adhesions. Separating the adhesions the third part of the duodenum came into view. The upper border between it and the pancreas was examined, but no trace of the diverticulum could be found. This part of the duodenum was then mobilized from the posterior abdominal wall and turned upwards. The mesentery and superior mesenteric vessels were drawn to the left. After a careful search, a slight thickening was seen on the posterior and upper border of the duodenum, behind the head of the pancreas. Separating the fascial covering at this point with the blades of dissecting scissors, the diverticulum came into

view. (Fig. 2.) It was found buried in the cellular tissue behind the head of the pancreas and attached to the fourth part of the duodenum. When entirely freed a clamp was applied near its base. A purse-string was run about the base and a ligature placed a quarter of an inch below the clamp. The diverticulum (Fig. 6) was removed by cutting between clamp and ligature. The stump was carbolized and inverted into the duodenum and the purse-string tied. The duodenum was allowed to fall back into its normal place. A drainage tube was inserted down to the lower border of the duodenum to drain the opened cellular space. The tube was passed outward through a small hole in the transverse mesocolon and brought to the surface through a separate stab wound in the abdominal wall. The transverse colon was returned into the abdomen in its normal position. The appendix which showed slight pathology was removed and the abdomen closed.

Comments.—The adhesions between the right half of the transverse colon and mesocolon and duodenum pointed conclusively to an inflammatory lesion in this region and could only be explained by the presence of the diverticulum, no other pathology being demonstrated.

A large part of the credit for the successful termination of this case is due to Dr. R. B. McQuay, of Portage la Prairie, who made the X-ray examination. He definitely showed that the barium was diverted into a pocket from the fourth part of the duodenum. Without this exact knowledge, I am sure I could not have found the diverticulum and the case would have gone on record as many others have done, " diverticulum shown by X-ray but not found at operation." This

Fig. 6.—Diverticulum 2½ by 3½ cm.

exact X-ray localization is not often done and may not always be possible; but it is essential if the operation is to proceed in an intelligent way for the removal of a diverticulum from the post-peritoneal or post-pancreatic space.

CASE IV.—A. T., female, October 6, 1926.

Primary Complaints.—1. A boring pain in epigastrium, slightly to the right of midline (two years). 2. Great distention with gas and much belching (three years). 3. Constipation and passing of mucus (two years). 4. Headaches with vomiting. 5. Loss of weight—forty-five pounds in three years; one hundred and thirty-five pounds to ninety pounds.

Family History.—Negative. No tumors, tuberculosis or nervous diseases.

Previous History.—Always healthy till 1918, when she had fibroids removed and appendectomy. Womb not removed. No children. Had pleurisy in 1915. It was tapped and a quart of fluid removed. She seemed to recover perfectly. Tonsillectomy ten years ago.

Present Illness.—Three years ago began to have headache and vomiting. Right side of head and down back of the neck. She always has to have the back of her neck rubbed and also between the shoulders. Has "neuritis" in arms and hands. This seems to come from the back. Headaches are not so frequent now as formerly. Has an "awful taste" in her mouth and feels as if there was poison in her system. Food does not relieve, but now if she goes a long time, four or five hours, she gets a gnawing pain, which is easier after eating. She does not eat well when she has the distress. She has been eating better lately, at times, but loses her appetite and feels miserable again.

The aches and pain in the right epigastrium and right hypochondrium go through to the back, lower dorsal and under right shoulder. The ache would go up the right side of the neck and "come out of the right ear." She said the glands in right side of the neck would be tender to touch.

In 1924, she went to bed for fourteen weeks and was on Sippy treatment, but did not improve. Went through two clinics and was ten weeks in sanatorium.

In 1925, she felt the cold so much she would shiver after a bath. Has weak spells and sweats a great deal. Her hands and feet swell at night. Sent to California for the winter, then went to Tennessee for several months. Returned to Winnipeg for the summer months. Stayed at Vancouver on her way home and a doctor drained her gall-bladder with a Rafhus tube. Has taken belladonna t. i. d. for months.

Examination.—A slightly undernourished woman. Medium height. Suprapubic scar. Abdomen full. No mass felt. Note tympanitic. Liver and spleen negative. Tenderness at Mayo-Robson's point and pressure here causes pain to shoot directly through to back, about twelfth rib, or just below it in costo-vertebral angle. P. V., negative. P. R., hemorrhoids, otherwise negative.

X-ray Report.—During and immediately following ingestion of opaque meal. The stomach is orthotonic, regular in outline and freely movable. The duodenal cap is normal.

Five-hour examination: The stomach is empty and there is a blob of barium opposite the body of the third lumbar vertebra. This was at first thought to be some of the opaque mixture retained in the crater of an ulcer.

Twenty-four-hour examination: At this time there is some of the barium in this sack.

Forty-eight-hour examination: The meal is throughout the large bowel. The sack is apparently empty. The colon has a spastic stringy appearance.

FIG. 7.—Diverticulum of third part of the duodenum. Five-hour plate.

Summary.—The sack which was seen at the previous examinations and thought to be crater of an ulcer, but on further study are now inclined to think it is a diverticulum of the third portion of the duodenum.

Operation.—High right paramedian incision. October 7, 1926, exploration of the stomach negative. Gall-bladder normal. (No stones, adhesions or thickening.) Kidney and spleen negative to palpitation. The duodenum was covered with an inflammatory veil, but no sign of ulcer and apparently not dilated. The great omentum was adherent to the incision of former operation in the lower abdomen.

Transverse colon and mesocolon were not adherent to the posterior parietal peritoneum as was noted in Case III.

The duodenum was mobilized by dividing the parietal peritoneum along its right border where it with the head of the pancreas could be turned to the left, exposing the posterior surface. The diverticulum was with difficulty located imbedded in cellular tissue attached to the third part (transverse part) of the duodenum. After ligature and carbolization of the stump it was inverted into the lumen of the duodenum by a double

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purse-string of No. o chromic catgut. A drainage tube was inserted down to the retro-peritoneal space and brought out through a stab wound in the right flank and the incision closed.

Convalescence uneventful.

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DIVERTICULITIS OF THE SIGMOID*

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THERE are four places in the intestinal tract where the onward flow of contents is normally retarded; the pylorus, ilio-cæcal junction, sigmoid and anus. These regions are more freely supplied with the annodal tissue of Kieth than other portions of the tract and are subject to the natural laws of the influence on motility and secretion resident in this tissue.

It is rationally claimed by clinicians of wide experience and mature judgment that 90 per cent. of all diseases of the gastro-intestinal tract occur in one or the other of these locations.

Pathological lesions involving the pyloric, ilio-cæcal and anal regions have long engaged the attention of physicians; their symptoms and management are now well in hand, but study of disease of the sigmoid, until quite recently, has been singularly neglected.

Although reference was made by Virchow in the middle of the nineteenth century to a pathological condition which we now believe to have been diverticulitis of the sigmoid; nearly fifty years elapsed before Grasser recognized and described this disease as a clinical entity.

Almost another decade passed, 1907, before the subject was taken up by W. J. Mayo, thoroughly studied and presented to the profession, since which time there has accumulated an extensive and increasing literature on diverticulitis. Many theories pertaining to causative factors in the production of diverticula of the sigmoid have been presented, the condition being commonly attributed to constipation and overdistention of the sigmoid by increased internal pressure from fecal contents and gas. Such causes are inadequate in the absence of some inherent defect in the bowel wall, if this were not so diverticula would be far more prevalent. Arrest in the development of the muscular coat has been suggested as a cause and is reasonably acceptable as one of the prerequisites to constipation and overdistention.

In the sigmoid of the embryo the longitudinal muscular fibres spread laterally in the bowel wall to within a short distance of the mesenteric border, the rest of the muscular coat is composed of circular fibres. In the area covered by circular fibres there are a number of little sacculations which normally disappear, along with the recessus intersigmoideus in the developmental changes; persistence of these little sacculations, perhaps constitutes the primary step in the passage of the mucous pouch through the muscular coat of the sigmoid. Spasm in the bowel wall with its concomitant retarding influence on the fecal stream, blood and lymph supply is also an important factor in the mechanics of diverticula.

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* Read before the Western Surgical Association, October 14, 1926.

By analogy one must conclude that spasm plays an important rôle in pathological processes encountered in the sigmoid. The diverticulæ appear as a series of hillocks on the serous surface of the bowel which may be mistaken for appendices epiploicæ.

Diverticulæ of the sigmoid vary in size and number, they are usually small, about the size of a 32 calibre missile and few in number, three to six or eight.

Pouches as large as a hulled walnut with a sessile base have been described. The smaller ones are pedunculated and some of them contain fecaliths of such density as to resemble a foreign body; those which are empty may, by pressure, be made to disappear into the lumen of the bowel.

In some specimens examined post-mortem the hernia-like protrusions of the mucosa were most numerous near the place of entrance of the blood supply to the bowel, thus in a measure, confirming the law of Harrison relative to intestinal hernia, viz.: that they are prone to follow the course of the blood-vessels.

From the area of fœtal sacculations the diverticula spread laterally into the field covered by longitudinal fibres, in some instances involving almost the entire circumference of the sigmoid, diminishing in size and number as the distance increased from the mesenteric attachment.

The lumen of the sigmoid in non-ulcerative subjects was markedly increased, the wall was very thin in the intervening spaces between the diverticulæ and the muscular fibres were attenuated by mechanical pressure and disuse or perhaps from congenital malformation.

In one specimen the muscular tract appeared to be well developed, the fibres constricting the neck of a diverticulum so tightly as to cause separation of the mucous pouch from its pedicle. This mucous sac, partly filled with a thin fluid, was between the muscular and serous coats, completely detached from its pedicle and surrounded by partly organized plastic exudate.

The process was evidently of recent origin and would no doubt have perforated had the patient lived; it was found in a subject dead of accidental drowning.

In chronic cases wherein the diverticulæ are complicated by infection, ulceration and perisigmoiditis, the lumen of the sigmoid is greatly diminished, amounting in some instances to angulation, deformity and complete obstruction. The devitalizing influence of internal pressure from spasm, fecal contents, glandular secretions and œdema favor germ invasion; necrosis and perforation of a diverticulum into a neighboring viscus, the peritoneal sac or the lumen of the sigmoid.

Perforation into the bowel is the most favorable, perhaps the most frequent result in this local necrotic process, which in such cases continues as an ulcer of the mucosa at the site of perforation. Adhesions between the sigmoid and another loop of bowel of the urinary bladder may lead to perforation into either viscus.

Accompanying diverticulitis there is usually a localized peritonitis with the

formation of a protecting plastic exudate which may, and in the greater number of instances does, prevent the calamity of perforation. Acute diverticulitis is comparable to acute infection in any other segment of the tract modified by anatomical construction and functional mechanism of the structures involved.

The symptoms so closely resemble those of acute appendicitis that the disease has been called left-sided appendicitis. This is true not alone of the early manifestations of the disease, pus, gangrene and perforation may rapidly follow the onset of symptoms and complete the analogy.

Muscular rigidity of the lower abdominal wall, pain in the region of the umbilicus radiating into the pelvis or left lumbar region, with frequency, a variable increase in temperature and pulse rate are the usual findings in acute diverticulitis. Nausea and vomiting sometimes accompany the symptoms and marked relief of short duration usually follow a free bowel movement.

Perforation may occur in a primary attack and this should be kept in mind while operating for acute perforation.

The upper end of the sigmoid has a very short mesentery and is covered by peritoneum only on the anterior and lateral aspects in 90 per cent. of the cases; this anatomical arrangement favors perforation outwardly, the pus and fæces burrowing between the bowel and the ilium downward into the pelvis. The following record of a patient seen many years ago by the writer illustrates some of the clinical features of acute diverticulitis with perforation.

The patient, a woman, aged thirty, had been ill for two weeks. Her chief complaint had been of severe pain in the lower abdomen; as she was pregnant and nearing term, the pain was mistaken for labor pains. The attack was accompanied by fever, her temperature at one time reaching 103° F. She was obstinately constipated, her feet and legs were swollen and the urine contained albumin and casts. Ten days after the beginning of her illness labor was induced and she was delivered of a dead fœtus.

Four days after delivery, when the writer first saw the patient, there was a large boggy mass opposite the left iliac spine and a fluctuating mass in the region of the left kidney. Vaginal examination revealed a tumor in the region of the left broad ligament to which fluctuation was imparted by tapping on the abdominal wall near the ilium. The diagnosis was, cellulitis of the left broad ligament with abscess formation.

An incision just within the ilium released a large quantity of dark, grumous material with a strong fecal odor; another incision in the lumbar region was followed by similar results. A drainage tube was inserted into either opening and the patient's condition, which had been bad prior to operation improved rapidly. The fecal fistula in the lumbar region closed in two weeks, the other opening discharged for five months and finally closed without further operation. The patient recovered, had marked relief from her constipation and was in good health one year later. This record bears the date of 1909, a time when surgeons were not thinking in terms of left-sided appendicitis, and although the diagnosis was wrong, fortunately for the patient, the right thing and no more was done to relieve existing conditions.

The diagnosis of acute diverticulitis is now fairly accurate in consequence of increased clinical experience and the signal assistance which has been rendered by X-ray studies in the last ten or twelve years.

One soon learns that attempts at closing these perforations at the primary

operation are futile, the bowel wall is œdematous, the sutures yield and the tissues fail to heal. There is, however, a favorable tendency to spontaneous closure after drainage, which may be hastened by direct exposure to the sun's rays and the use of bismuth paste.

In the chronic form of the disease, the patient gives a history of having had repeated attacks which were followed by headache, nausea, loss of appetite, joint involvement and other symptoms of faulty elimination.

A tumor may be felt in the region of the sigmoid. These patients are usually constipated but may have troublesome attacks of diarrhœa which will be benefited by repeated, round doses of castor oil.

The differential diagnosis should include special reference to lues, tuberculosis and malignancy.

The sigmoidoscope in our hands has added nothing to the certainty of diagnosis in the acute form of the disease owing to the pain occasioned by its use, it may, however, be very serviceable in the chronic cases wherein the lumen of the sigmoid is not distorted. A correctly interpreted röntgenogram is the best aid to diagnosis.

Objectives in the management of chronic diverticulitis include removal of focal infection, relief of constipation, regulation of diet, rest in bed, and the use of drugs as indicated. Such treatment will benefit many of these patients, but if a tumor be present the unhappy thought comes to mind of the possibility of malignancy, either co-existing or developing later in the margin of an ulcer and of temporizing until the favorable time for removal will have passed. Blood in the stool speaks for ulcer, but does not indicate the character, whether malignant or benign.

If we will remember the clinical dicta, that an inflammatory disease is wavy in its course, that the symptoms come and go, that cancer is a continuous destructive process, it will assist in making the diagnosis. Resection of the sigmoid with end-to-end anastomosis is the ideal treatment for diverticulitis and the tendency at present as indicated in the literature is to strive for this ideal. Operative mortality is too great in unselected patients to warrant this practice. Resection in selected patients is a comparatively safe procedure, but in debilitated or aged patients the mortality is high; they are prone to develop pulmonary complications, infections, pericarditis or joint involvement after operation.

We have found that by giving the patient opium for two or three days prior to, and an intravenous saline injection at the time of operation, lessens the operative risk of resection. In patients requiring operation, results will be infinitely better if operation is done in two or three stages. A preliminary colostomy with sufficient interval to permit of subsidence of the accompanying inflammatory changes before attempting resection and reëstablishing continuity of the bowel, will be followed by less operative mortality and better end results than those following complete primary operation.

Mikulicz technic as modified by C. H. Mayo is the simplest and most

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satisfactory method of dealing with tumor, contracted lumen and obstruction of the sigmoid.

At the Cincinnati General Hospital there was but one patient admitted suffering of diverticulitis with perforation in the year 1925. From 1915 to 1925, there were two patients who died of some other disease wherein diverticulæ of the sigmoid were found at autopsy. The admissions to this institution number 10,000 patients annually, of which approximately 20 per cent. are referred to the surgical service.

There were 20 carcinomata recorded in the list of diseases of the sigmoid during the same period.

At another hospital with which the writer is connected there was one patient with diverticulitis and perforation and one with diverticulitis and adhesions admitted in the past five years. Frequent consideration of pathological lesions which are infrequently encountered with free interchange of ideas tends to create alertness in the recognition of such conditions and prevention of errors in the diagnosis and treatment.

THE MORTALITY IN APPENDICITIS*

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Cases of appendicitis not requiring drainage are of very little statistical interest, as nearly all such patients recover; not one in my own hands has died. But I want to put on record my statistics of complicated cases of appendicitis, though I have comparatively few to report. There are two reasons why I have so few of such cases. The first reason is that for the past ten years I have not done myself very many emergency operations for appendicitis; I have two good associates who do nearly all my emergency work. The other reason is that I have made it a rule, to which there are few exceptions, to operate *immediately* on every patient with acute appendicitis; and I am sure that in this way the number of cases requiring drainage has been kept low. Perhaps a third reason might be added, and that is the fact that fewer patients are sent into the hospital so late that complications have already developed; when I first began to operate, and was doing only emergency work, nearly every patient required drainage; whereas now my associates and I find that in a majority of emergency operations the wound may be closed.

Up to October 1, 1926, I find I have operated with my own hands on 247 patients with appendicitis so far advanced as to require drainage. (See Table.) I have divided the cases into:

1. Those patients who were operated on as soon as possible after admission to the hospital.

2. Those in whose cases operation was delayed because it was thought immediate operation would hasten death.

247 COMPLICATED CASES OF APPENDICITIS (TO OCTOBER 1, 1926)
Operation on Admission to Hospital

	Total	Recovered	Died	Mortality Per cent.
Primary abscess	98	90	8	8.1
Gangrene	44	42	2	4.5
Diffuse peritonitis	68	57	11	16.1
	210	189	21	10

Delayed Operation (Cases of Diffuse Peritonitis)

	Total	Recovered	Died	Mortality Per cent.
Died without operation	6	0	6	100
Abscess drained, appendix not removed	20	13	7	35
Abscess drained, appendix removed	11	11	0	....
	37	24	13	35
Total	247	213	34	13.7

* Read before the Philadelphia Academy of Surgery, October 4, 1926.

1. *Operation on Admission.*—These cases are subdivided further by the clinical diagnoses made at the time of operation into cases of:

Primary Abscess.—I mean by this that the patient develops an abscess during the attack, but without having first passed through any state which can be recognized from the patient's own history or from the attending physician's report as diffuse peritonitis. The mortality in my cases is 8.1 per cent.

Gangrene.—By this I mean gangrene of the appendix with peritoneal contamination sufficient to require drainage of the wound, but without a walled-off abscess. The mortality in my cases is 4.5 per cent. I think gangrene of the appendix deserves recognition as a clinical entity apart from primary abscess. But some cases of gangrene of the appendix are accompanied by so little peritoneal soiling that no drainage is required. No such cases are included in this series. I do not believe that *perforation* of the appendix, as such, deserves recognition as a clinical entity: if the perforation occurs into preformed adhesions, the case is one of abscess or gangrene; if it does not occur into preformed adhesions, it produces *diffuse peritonitis.*

Diffuse Peritonitis.—This term I use purposely because it is noncommittal. It does not define how widespread the peritonitis is, because I do not know; and at operation I do not find out. All I see at the operation is the appendix and base of the cæcum; very occasionally some of the small bowel comes into view. On opening the peritoneum there is free turbid fluid spread diffusely in the abdomen, not localized by adhesions. Usually the fluid first encountered is only seropus, but sometimes it is frank pus. There is more or less inflammatory lymph on the structures which are seen; and there is pus in the pelvis or in the right flank or in both (where the cellular contents of the seropus have collected by gravity); but there are no localizing adhesions. And because no exploration is done beyond the regions mentioned, I do not know how widespread the peritonitis may be. But from the physical examination of the patient before operation, and because sometimes (after first sucking the pelvis and right flank dry, and then raising the head of the table) I have been able to suck more pus out of the pelvis, I surmise that the peritonitis is *diffuse* (that is, not localized), without being *general.* By the latter term I mean peritonitis which involves all, or very nearly all, of the peritoneal cavity—not only the pelvis and both flanks, but also the regions of the spleen, liver, stomach, and beneath the diaphragm. On such patients I do not operate, because operation will only hasten death.

It is difficult to express in words any rule for determining before operation which are cases of diffuse and which of general peritonitis; each patient is a law unto himself. But usually *so long as the degree of abdominal rigidity is greater than the distention,* the case may be classed in the former category; and in such cases I have not postponed operation. Many cases of early diffuse peritonitis, showing only excess of turbid fluid, will not require drainage after operation. Such cases are not included in this series. The mortality in my cases of diffuse peritonitis requiring drainage is 16 per cent.

This is high, but I believe very few of the patients who died could have been saved by any other treatment.

2. *Delayed Operation.*—If I thought a patient admitted with peritonitis was so ill that operation on admission would surely hasten death, then operation was delayed; and the patient was treated for peritonitis by the strictest code of the Ochsner *régime:* nothing but the stomach tube by mouth; instillation of fluids by rectum, etc.; morphin. Of 37 such patients under my personal care, 6 died without operation, never reacting at all. These cases should be counted in any computation of mortality, because naturally it is the mortality of the disease, not only the operative death rate that is of interest. Twenty patients reacted so as to form one or more abscesses which could be recognized; and these abscesses were opened without attempting to remove the appendix: of these 20 patients 7 died, a mortality of 35 per cent. Eleven patients reacted so completely that it was thought advisable to remove the appendix at the time the abscess was drained; none of these eleven patients died. So that among 37 patients considered too ill for operation on admission to the hospital, there were 13 deaths, a mortality of 35 per cent., to be compared with a mortality of 10 per cent. when prompt operation was thought wise. No one can claim infallible judgment, and no doubt errors of decision occurred in some cases. This total mortality of 13.7 per cent. (34 deaths among 247 complicated cases of appendicitis) is to be compared with the absence of mortality in cases of acute appendicitis without the complications of abscess, gangrene, or peritonitis. The life of every one of these 34 patients could have been saved if the family or the family's physician had insisted on immediate operation at the onset of the disease. This statement is not invalidated by the fact that many patients may have been treated at home with recovery: *to delay operation in acute appendicitis is to gamble with death.*

Perhaps I should add that a very few patients, in whose cases operation was postponed because of widespread peritonitis, recovered without forming any abscess at all; these cases are not included in this series (though to do so would reduce my mortality) because at operation no cause was found for drainage, and I have no means of knowing that the patients did certainly pass through an attack of peritonitis there was *nothing* found at operation to prove the previous existence of widespread peritonitis.

Finally, may I make this remark: I think we ought to recognize that those surgeons, who advocate delay in resorting to operation, are quite likely to err by classing as *recoveries due to delay* cases in which the patients were never very seriously sick in the first place; cases, I mean, in which many surgeons (as I believe correctly) would operate promptly, and find that the wound could be closed without drainage, and there would never be any question of the patient's recovery. Only those surgeons who look inside the belly can know the true condition of affairs during the acute stages of the disease.

THE REPAIR PROCESSES IN WOUNDS OF TENDONS, AND IN TENDON GRAFTS

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Heretofore the surgical treatment, especially after operation, of wounds involving the flexor tendons of the hand, has been attended by considerable empiricism. No attempt has been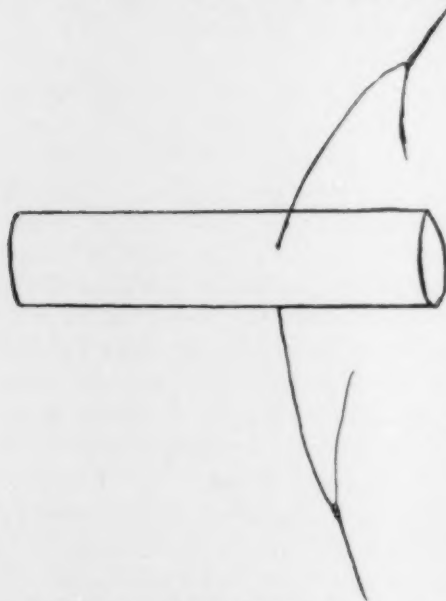 made to demonstrate by exact experimental methods, the reasons for the various procedures that have been used. For instance, no one has as yet thrown definite light on the question as to when it is safe to institute m o t i o n following tenorrhaphy. Then again, it has been asserted in various quarters that something unusual occurs at the site of tenorrhaphy between the sixth and ninth days after operation, which jeopardizes the suture line, making any form of motion during this period inadvisable. Among other things, a study of this kind involves a consideration of the processes of repair attending the operations of tenorrhaphy and free tendon grafting. The following study was therefore undertaken with a view of determining the rationale of various operative and post-operative procedures and of ascertaining a clear conception of the repair processes.

Great difficulties were encountered in the early part of the work in obtaining adequate tendon tissues to work with. The best experimental animal in a study of this kind is the monkey, because the structures are practically identical with those found in the human being. Because of the number of animals necessary, utilization of this animal, of course, became impossible. Rabbits were

DIAGRAM 1a.—*Method of Suturing Tendons.*—At *a*, the suture material is passed transversely through the tendon, about ¾ of an inch from its extremity. Both ends of the suture are threaded on fine straight needles. One of the needles is made to pass obliquely through the tendon as shown at *b*, coming out on the opposite side. The other needle is passed through in similar manner, coming out at the opposite side of the point of exit of the first needle. This is shown at *c*. The needles are then passed again obliquely through the tendon and made to come out at the end as indicated at *d*. The only points of the suture material which lie on the surface of the tendon are indicated at A. Figures *e* and *f* indicate the anterior and posterior aspects of the tendon, showing the amount of suture material visible on the surface. When the knots are tied, uniting the proximal and distal extremities of the divided tendon, it will be seen that they lie buried between the tendon ends. They should be tied in such a way as to cause "buckling" of the tendon at the site of repair. The same technic is used for an insertion of a free tendon graft with the exception that four sutures are placed instead of two.

next used, but it was soon found that the tendon structures were too small and that the animals did not lend themselves easily to the prolonged immobilization of an extremity in a plaster cast. It was finally decided to use dogs. This animal does not present any tendon structure similar to that found in the flexor tendon of the hand, *i.e.*, the epitenon variety where the tendon glides freely in an encircling sheath. The type of tendon mechanism nearly approaching that f o u n d in the human is that seen in the anterior tibial group. These tendons, in addition to an enclosing sheath, have a mesotenon which is attached to the deep surface of the tendon and which contains the nutrient blood-vessels.
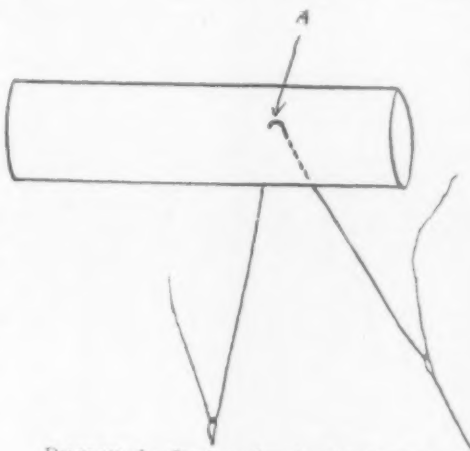
DIAGRAM 1*b*.—See legend under Diagram 1*a*.

In general, the type of operation was made as simple as possible and to approach as nearly as possible the procedure used in the human. After thorough shaving and cleansing of the skin of one hind leg, the operative field was carefully prepared and an incision made anteriorly so as to expose the anterior tibial group of tendons. Making use of an atraumatic technic, the sheath was divided and the tendons isolated. In order to simulate as closely as possible the anatomy of the flexor tendon in the human, the t e n d o n was separated from its mesotenon. Then two varieties of experiment were done. In the first, the tendons were divided and then resutured, according to the technic described in the protocols (see Diagram 1); the tendon sheath was then carefully repaired, the subcutaneous tissues were approximated and the skin sutured. A light plaster cast was applied with the ankle, knee, and hip-joints in acute flexion. At varying times, starting with the second and third post-operative days, the casts were cut down and passive motion instituted. This was done daily until a period when the cast was entirely dispensed with, varying from the fifth to the eighteenth day after operation.

DIAGRAM 1*c*.—See legend under Diagram 1*a*.

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In the second type of experiment, the same technic was employed in exposing the tendons. A portion of tendon, measuring about 2 cm. in length, was excised from the left hind leg and a free tendon graft, taken from the right hind leg, was inserted into the deficiency, employing the technic to be described later. (See Diagram 1.) The parts were immobilized and the same after-care instituted. At varying times, following the removal of the cast, the animals
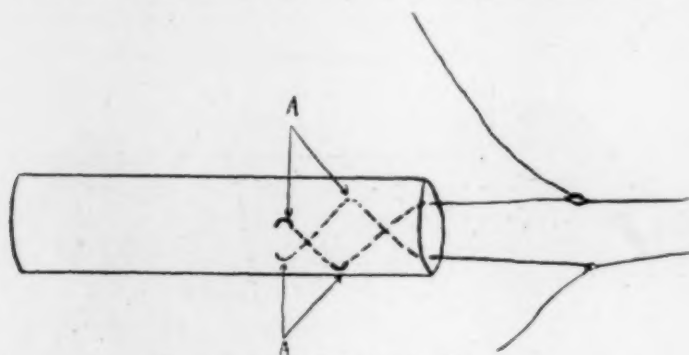
DIAGRAM 1d.—See legend under Diagram 1a.

were again anæsthetized and the repaired tendons were removed for microscopic study. The gross findings at the second operation were carefully noted.

PROTOCOLS

Experiment No. 1. D o g No. 8 1 4 6.—The left hind leg was carefully shaved with soap and w a t e r, followed by thorough c l e a n s i n g with benzine, alcohol and ether. It
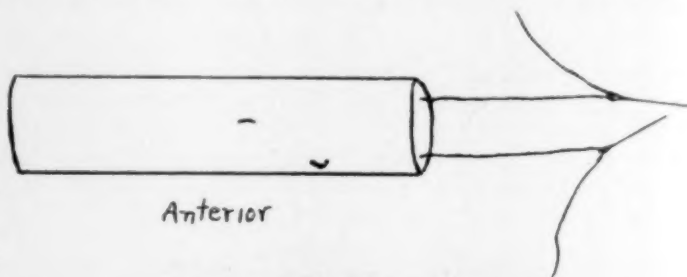
Anterior

DIAGRAM 1e.—See legend under Diagram 1a.

was then painted with 3½ per cent. iodine. Longitudinal incision was made over the anterior aspect of the leg; all bleeding points carefully ligated. The tibialis anticus group of tendons was isolated after making a small longitudinal incision in the tendon sheath. The mesotenon was separated from the posterior aspect of the tendon. The tendon was then d i v i d e d transversely with a r a z o r blade. Sutures consisting of fine silk on fine straight needles w e r e
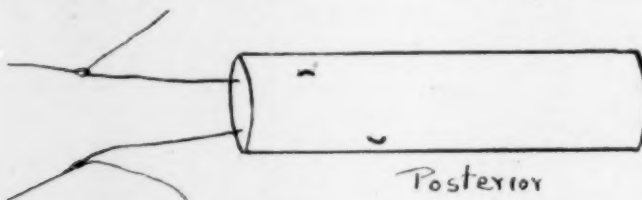
Posterior

DIAGRAM 1f.—See legend under Diagram 1a.

then inserted in the proximal and distal stumps according to the Bunnell technic. The four strings of silk were then tied together so as to bury the knots between the tendon ends. The anterior annular ligament of the ankle-joint, a definite thickened structure in the dog, was left intact. The tendon sheath was repaired with interrupted stitches of fine catgut. The skin and subcutaneous tissues were sutured with a continuous stitch of silk. A plaster case was then applied with ankle, knee, and hip-joints in flexion. On the seventh post-operative day, the case was cut down and passive motion instituted in the ankle and

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knee-joints. The range of motion was gradually increased. The case was removed on the tenth post-operative day. The wound had healed per primam. On the twenty-sixth post-operative day, the dog was again anæsthetized and the wound reopened. It was found that the repaired tendon was adherent to the tendon sheath at the site of suture. There was no gross evidence of the silk sutures. The tendon, however, separated easily from the tendon sheath. The specimen was excised for microscopic study.

Experiment No. 2. Dog No. 8158.—The identical procedure was used here, as in Experiment No. 1. The case was removed on the seventh post-operative day and the

FIG. 1.—Section of specimen removed in Experiment No. 1. Simple tenorrhaphy using silk which is shown at *A*. The scar between the tendon ends is indicated at *B*. Note the vascular connective tissue encircling the tendon at this point. There is no evidence of the knots between the tendon ends.

wound was reopened on the ninth post-operative day. At this time, it was found that the suture line was intact, and there were numerous adhesions between the tendon sheath and the proximal part of the tendon. The specimen was excised for study.

Experiment No. 3. Dog No. 8166.—The same technic was again used. The plaster case was loosely applied, allowing a moderate range of motion from the very beginning. The case was removed on the sixth post-operative day and the wound was reopened on the eleventh post-operative day. It was found that the sutured tendon

FIG. 2.—Simple tenorrhaphy with removal of the immobilizing case on the seventh post-operative day. The line of suture is shown at *A*. The suture material is visible at *B*. Note the beginning replacement of the scar tissue by the specialized formed connective tissue of the tendon at this early date.

had pulled apart with the silk sutures stretching between the divided ends. There were numerous adhesions between the tendon stump and the tendon sheath. This experiment, supported by three or four others with similar results, proves the inadvisability of allowing active motion from the first post-operative day.

Experiment No. 4. Dog No. 8213.—The same operative procedure was instituted in this case. The case was applied in the usual manner. Passive motion was instituted on the fourth post-operative day. The case was removed on the twelfth post-operative day. On the twenty-eighth day, the wound was reopened and it was found that the tendon was intact but somewhat thinned out. The specimen was excised for study.

Experiment No. 5. Dog No. 8334.—The same technic was again used. Passive

motion was not instituted until the case was removed on the seventh post-operative day, on which date the wound was found firmly healed. On the twenty-third day, the wound was reopened and the tendon was found intact. It was bulbous at the suture line and adherent at this point to the tendon sheath. The specimen was excised for study.

Experiment No. 6. Dog No. 8366.—The same technic was used with the exception that the mesotenon was not divided. Motion was started on the ninth post-operative day when the case was removed. The wound was reopened in three weeks, and it was found that the suture line was intact, but that the tendon was moderately adherent throughout its length.

Experiment No. 7. Dog No. 8382.—The same technic was used as in the former
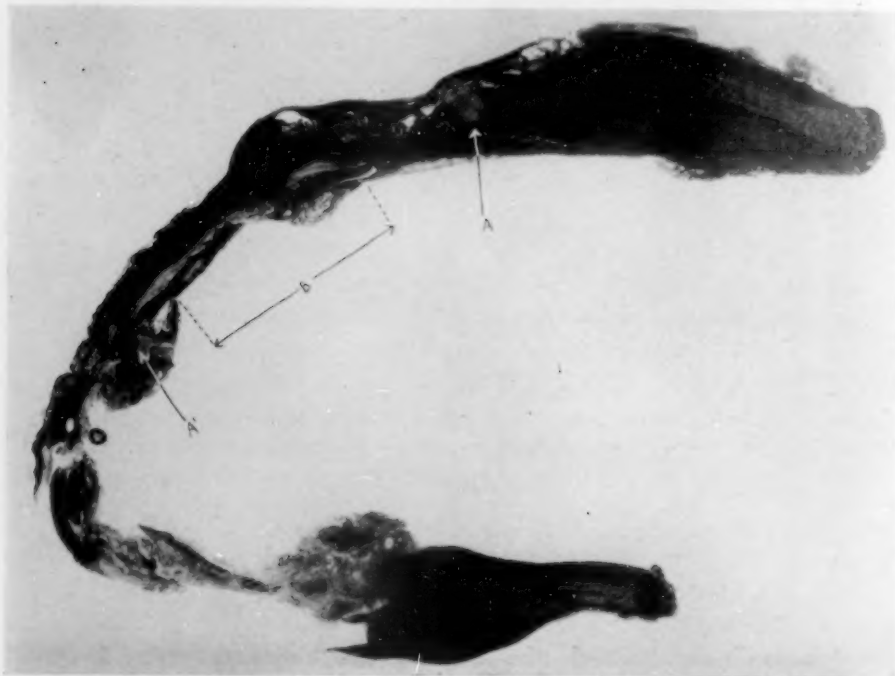
Fig. 3.—Simple tenorrhaphy; passive motion instituted on the fourth post-operative day; case removed on the twelfth day; specimen excised on the twenty-eighth day. Suture material visible at A and A'. The point of tenorrhaphy visible at B. Note the stretching of the tendon and scar at this point with minimum scar tissue between tendon and sheath. The stretching is probably due to early motion.

experiment with the exception that the tendon was divided at a point distal to the annular ligament. No motion was allowed until the ninth day, when the case was removed. The wound was reopened on the twenty-first day, and it was found that the point of suture was bulbous and adherent to the sheath. The specimen was excised.

Experiment No. 8. Dog No. 8383.—The same procedure was used as in the preceding experiment. No motion was allowed until the ninth day, when the case was removed. The wound was reopened on the nineteenth day, but the tendon was found firmly adherent to the tendon sheath at the point of suture. The specimen was excised.

Experiment No. 9. Dog No. 8389.—The same procedure followed. The case was removed on the eighth day. The wound was reopened on the sixteenth day. It was then found that union was firm, and the tendon was only very lightly adherent to the sheath at the point of suture. The specimen was excised.

Experiment No. 10. Dog No. 8402.—The same technic as in the preceding experiment. No motion was allowed until the tenth day, when the case was removed. The wound was reopened on the nineteenth day, and it was found that the tendon was firmly

united with moderate adhesions between the sheath and tendon and evidence of fatty degeneration of the muscle belly of the tibialis anticus. The specimen was excised.

Experiment No. 11.—Dog No. 8468.—Both hind legs were prepared as described in the preceding experiments. Both anterior tibial tendons were isolated in the same manner, using a careful atraumatic technic. On the left side, a piece of tendon, measuring 2 cm. in length, was removed after separating off the mesotenon. Making use of the principle of Mayer, namely, that, when the origin and insertion of a muscle are approximated as close together as possible, the tension of the tendon should be zero, the origin and insertion of the tibialis anticus were approximated by flexing the various
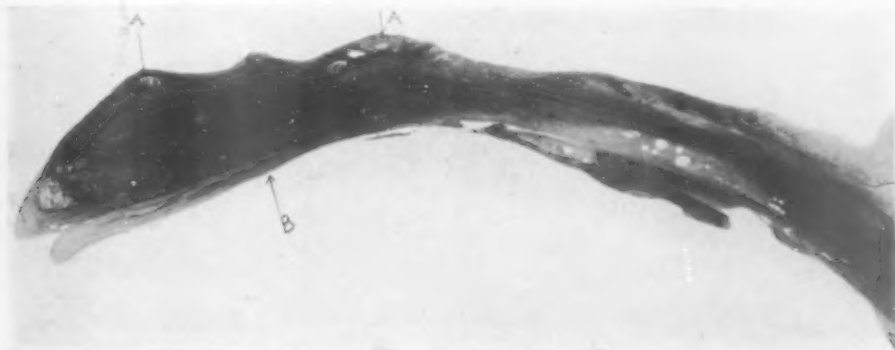
FIG. 4.—Simple tenorrhaphy using silk sutures with removal of cast on the seventh post-operative day. Specimen was excised on the twenty-third day. The sutures are visible at *A*. Note the dense scar tissue at the site of union, *B*. The relative absence of connective tissue on the surface of the tendon is noteworthy.

joints and the distance between the divided ends measured with calipres. A free tendon graft of the same length as the deficiency just measured was then taken from the right tibial tendon and placed in the defect on the left side, making use of fine silk inserted according to the method of Bunnell. The tendon sheath was then sutured with inter-

FIG. 5.—Simple tenorrhaphy with the tendon divided at a point distal to the anterior annular ligament. The case was removed on the ninth day. The specimen was excised on the twenty-first day. The vacuolization noted at *A* marks the site of a suture inserted at the proximal stump. Note the firmness of repair and the replacement of the scar tissue by formed connective tissue. The adhesions along the surface of the tendon, *B*, are well-developed.

rupted stitches of plain catgut. The wound was closed and a plaster case applied as previously described. On the eleventh post-operative day, the cast was removed and the animal allowed to run about. On the eighteenth post-operative day, the wound was reopened and it was found that there was no infection. One silk suture in the region of the graft had become loosened. The sheath was markedly thickened. The graft was intact and firmly united, and it was adherent to the tendon sheath. The specimen was excised for study.

Experiment No. 12. Dog No. 8482.—The same procedure as described in Experiment No. 11 was repeated in this animal. The case was removed on the ninth day,

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and the wound was reopened on the fourteenth day. It was found that the distal end of the graft had separated from the distal end of the divided tendon. The proximal end of the graft had become united but four-fifths of the graft had degenerated.

Experiment No. 13. Dog No. 8491.—The same procedure was followed in this case as in the preceding two experiments. The plaster case was removed on the ninth post-operative day and active motion allowed. The wound was reopened on the fourteenth day, and it was found that the graft had become firmly united with light adhesions between it and the tendon sheath. Suture material was not visible. The specimen was excised for examination.

NOTE.—Numerous similar experiments were performed as described in the preceding three. The period of immobilization varied from the eighth to the twentieth days.
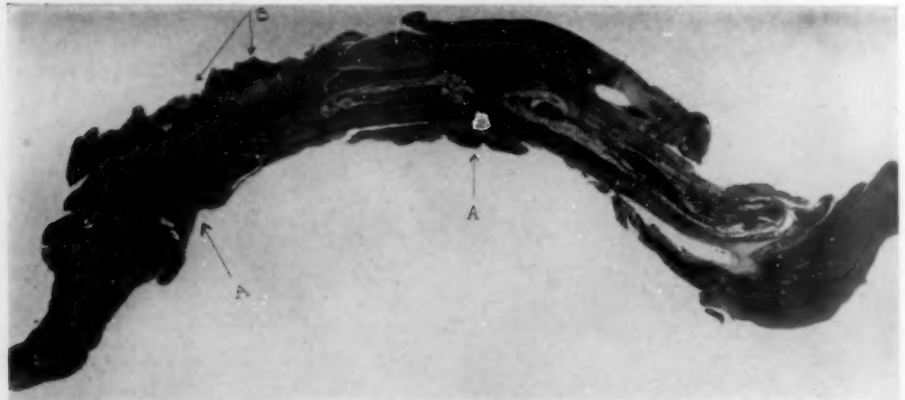
FIG. 6.—Simple tenorrhaphy; no motion was allowed until the twelfth day. The specimen was excised on the nineteenth post-operative day. Note the extensive adhesions on the surface of the tendon at A, due to the prolonged immobilization. The trauma caused by removal of the specimen is visible at B.

Specimens were excised from the twelfth to the thirty-first day post-operative for microscopic study.

Repair Processes. Simple Tenorrhaphy.—From an examination of the microscopic sections, obtained during these various experiments, it appears evident that a scar forms, as elsewhere in the body, between the divided ends of the tendon. The component elements at the initial stage are composed of fibrin probably from both coagulated blood and the synovial fluid found in the tendon sheath. In addition to these elements there are seen also the various types of blood-cells. With the suture remaining intact, young fibro-blasts and fibrils grow out from the proximal and distal ends of the tendon and probably from the sides of the injured tendon sheath, along the network of fibrin. This, with the outgrowth of small capillaries and the accumulation of a small number of mononuclear leucocytes constitutes the young scar. During the first three days following the tenorrhaphy, this scar cannot withstand stress and strain. The intact suture is the restraining factor in the prevention of stretching and separation of the tendon ends. After the fourth day examination of the sections showed that the suture material swells and the knots between the tendons have a tendency to loosen. It is after this period that the scar tissue of itself becomes the bulwark in the maintenance of the continuity of the tendon. With stress and strain applied on the fifth

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day, in the form of passive motion (in experimental animals only), it appears from the sections that the scar joining the tendon ends stretches somewhat, but not to any marked degree. This presupposes that the motion employed is not extensive at the beginning. Following this day the institution of active motion in these animals, which occurred when the plaster casts were removed, showed that the scar was capable of withstanding a considerable amount of strain without any evidence of stretching or separation provided the wound was clean.

Some observers have reported that, in a tenorrhaphy, something occurs at the point of suture between the sixth and the ninth days post-operative,

FIG. 7.—Simple tenorrhaphy; cast removed on the eighth day. Specimen excised on the sixteenth day. The suture material is visible at A. The firm union and the lack of any marked adhesions, is noteworthy.

which causes a weakening in the scar. They have therefore cautioned against any form of motion during this critical period. The experiments reported in this paper do not bear out this contention. On the contrary, it appears that, following the fifth day, the scar tissue between the divided ends of the tendon progressively increases in strength and density up to the day when the union is as firm as it ever will be.

In the specimens removed at about the twenty-eighth day, it was found difficult to determine in the gross exactly the point of suture, except for the presence of adhesions to the tendon sheath. This was further emphasized in the microscopic sections which seemed to show that the specialized formed connective tissue of which tendon is composed, entirely replaces the scar tissue, first visible between the tendon ends. The sections disclose an almost unbroken line from the proximal to the distal segments.

In the early stages of repair, the suture material is visible microscopically between the tendon ends. About the seventh or eighth day, following the period when swelling occurs in the suture material, the knots between the tendon ends begin to disintegrate. As early as the fourteenth post-operative day, sections fail to reveal the knots between the tendon ends. However, that

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part of the suture material which is placed in the body of the tendon proper, remains and is visible in every section made in the experiments reported in this paper. It is probable that this portion of the suture remains unchanged for an indefinite period.

It is interesting to note the various changes that occur at the site of union between the tendon and the sheath, from the day of operation to the time when the repaired tendon has returned to practically a normal state. The train of events, pieced together from the various microscopic sections, seems to be as follows. No matter how carefully one conducts his operative technic, there is considerable trauma at the site of tenorrhaphy both on the surface of the tendon and its surrounding sheath. This trauma may only
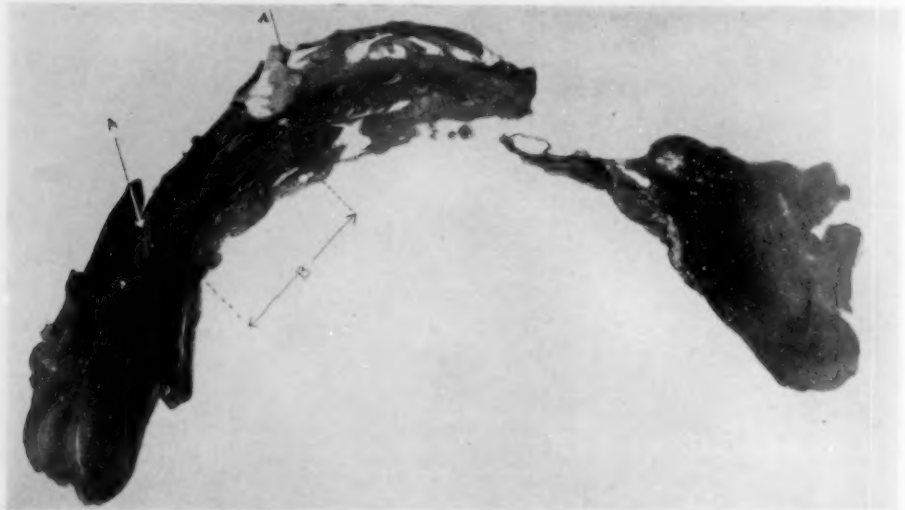
Fig. 8.—Simple tenorrhaphy; motion not started until the tenth day when the case was dispensed with. Suture material visible at A. The site of tenorrhaphy visible at B.

be microscopic, but enough to cause the rubbing off of the endothelial cells lining the tendon sheath and the surface of the tendon. Following this trauma, the tendon becomes adherent to the tendon sheath. During the period of immobilization, young fibroblasts grow outward from the subendothelial tissues of the sheath and from the tendon itself and more firmly unite the two structures. Following the institution of motion, the contraction of the muscle belly controlling the tendon causes periodic stretching of this early scar between the tendon and its sheath. As time goes on and the muscle contractions become more pronounced, the stretching is more accentuated. This causes an elongation of the various connective-tissue cells joining the tendon and sheath, until finally they break at the point of maximum tension, usually at the branched extremities of the cells. With the constant to and fro gliding mechanism, the cells now lining the surface of the tendon and the tendon sheath, show a gradual adaptation to their new function and assume the microscopic appearance of the flat endothelial cells lining the normal tendon and sheath. Both in these experiments and clinically, in two

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cases of flexor tenorrhaphy which were operated upon a second time for a new lesion, it was impossible to demonstrate the exact point of suture, there being no evidence of adhesions between tendon and sheath.

Tendon Grafts.—The main inquiry in the study of the repair processes involved in free tendon grafts is centred about the question of whether the graft lives as such, or forms a bridge, as in bone grafts, along which cells grow from the proximal and distal ends of the repaired tendon. The experiments reported in this paper show definitely that the graft lives as such and that the repair proceeds along the same lines as described in the preceding section. Of course, there are numerous biochemical and biophysical phenomena
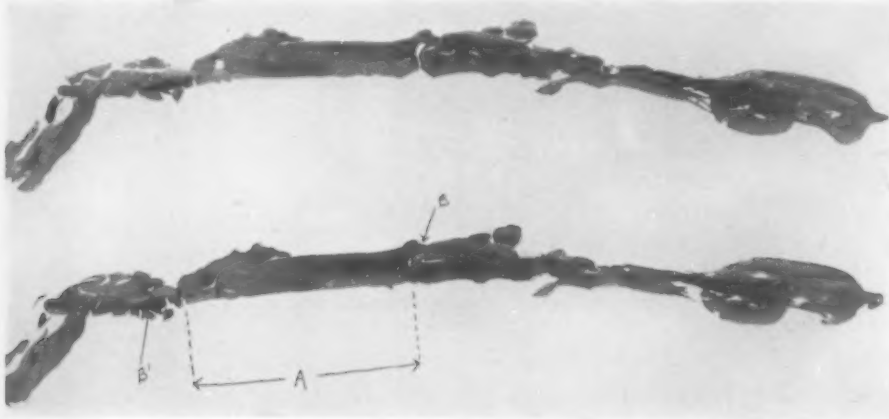
FIG. 9.—Free tendon graft in a rabbit. The animal was found dead in its cage on the tenth postoperative day, on which date the specimen was excised. In the gross, the tendon appeared viable, with the suture lines intact. The above section shows the graft at *A* with the suture material visible at *B* and *B'*. High power examination shows that there is complete disintegration of the cells composing the graft.

involved here, the exact nature of which can be explained only by conjecture. It is probable that the graft derives considerable nutrition from the tissue juices, whether they be derived from the endothelial lining of the sheath or the surrounding connective tissue. Just what amount of nutrition is derived from these sources, it is difficult to say. In any event, the graft soon becomes united by scar tissue to the proximal and distal ends of the tendon and also to the enclosing sheath. It is probable that the main source of nutrition is derived from the outgrowth of young capillaries and lymph-vessels from the tendon ends and from the subendothelial tissues of the sheath.

In the initial five or six days, a certain amount of swelling occurs in the graft which, microscopically, shows it to be caused by an increase in size of its component cells. The nuclei are not as definitely outlined as in the normal tendon and stain irregularly. Following this period, the swelling subsides and the cells assume a normal appearance. By this time, there has been a practically complete outgrowth of capillaries, reassuring the nutrition of the graft. Following the seventh or eighth days, the repair proceeds in exactly the same manner as in simple tenorrhaphy with the exception that there are two scars to be considered and an area of union between tendon

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and sheath stretching for a distance corresponding to a little more than the length of the graft itself. The separation of the tendon from its surrounding sheath apparently follows the same process as described in the preceding section.

In the cases of both tenorrhaphy and tendon graft, the immobilization produced in all the animals some degree of atrophy of the muscle bellies controlling the tendons. It varied from a slight atrophy of the muscle characterized by an increase in fibrous tissue, to a marked fat replacement, visible in the gross.

Discussion.—It appears from the preceding description and an examination of the various sections made during these experiments, that very definite
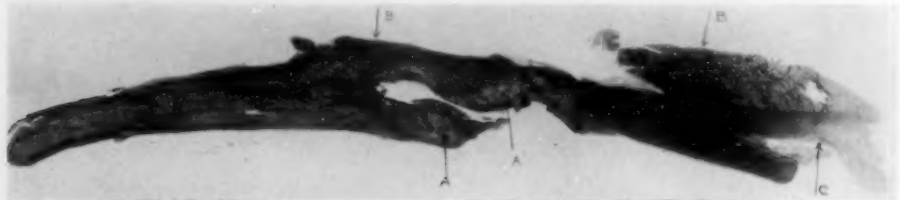
FIG. 10.—Free tendon graft. Motion was instituted on the eleventh post-operative day. The wound was reopened on the eighteenth day and the specimen excised. The graft was found to be intact and intimately adherent to the tendon sheath. The suture material is visible at *A.* Note the union of the graft to the distal segment of the tendon at *B.* Proximal segment of the tendon is visible at *C.* Adhesions are noted at *D.*

data have been obtained, which can be used to advantage clinically. In the first place, it is felt that definite information has been obtained regarding the time when motion can be started following a tenorrhaphy. Providing the wound is clean, it is reasonable to assert that *active* motion within the limits of pain can be instituted on the fifth post-operative day. It is felt that it would be dangerous to employ *passive* motion in this type of case sooner than the fifteenth or sixteenth post-operative day, because it is impossible for the surgeon to gauge the amount of tension he is applying at the site of repair, commensurate with the strength of the scar tissue joining the tendon ends. Active motion, however, is safe when carried out within the limits of pain, because the patient is able to gauge accurately the amount of strain he is placing on the suture line by the pain produced when the tendon pulls away from its loosely adherent sheath.

The whole object in instituting early motion following a tenorrhaphy is to prevent the formation of firm adhesions between the tendon and its sheath. It is felt that following the fifth day, the carrying out of daily active motion for a period of ten to twenty minutes, under the direct supervision of the surgeon himself, will give the greatest opportunity for a return of the tendon to its normal state. It is also felt that between these periods of exercise, a proper retentive apparatus should be worn by the patient which will place the suture line under least tension. In this connection, the experiments seem to show that union is firm enough about the eighteenth day to allow for the discontinuance of the retentive apparatus.

The data obtained regarding free tendon grafts indicate that it is safe to institute active motion about the tenth post-operative day, maintaining the retention apparatus during the periods of inactivity. It also seems that it is unwise to remove this apparatus until about the twenty-fifth day, post-operative.

It is unnecessary in this paper to enlarge upon any other form of therapeutic remedy such as light massage, radiant heat, etc., because they have proved to have definite value in the post-operative care of these cases. (See ANNALS OF SURGERY, vol. lxxxi, 1925, p. 111.)

CONCLUSIONS

1. After the operation of tenorrhaphy, using the technic outlined in this

FIG. 11.—Free tendon graft. Motion was started on the ninth post-operative day and the wound re-opened on the sixteenth day. In the gross, the graft was found to be firmly united, but with light adhesions between it and the sheath. The section shows the suture material in the graft itself at A and in the proximal and distal ends of the tendon at A'. Note the firm union between these points and the viability of the cellular structures of the graft. The lack of adhesions is noteworthy.

paper and previous publications, repair of the tendon proceeds along definite lines both as regards the time element and the gross and histological pictures.

2. It is safe to institute active motion on the fifth post-operative day and to remove the retentive apparatus on the eighteenth post-operative day, after which the repair will have proceeded to a point where the scar can withstand considerable stress and strain.

3. Free tendon grafts, inserted to bridge a defect in a tendon, live as such.

4. It is safe to institute active motion after the insertion of a free tendon graft on about the tenth post-operative day and to dispense with the retention apparatus on about the twenty-fifth day.

5. The return of function following a tenorrhaphy, or the insertion of a free tendon graft, is dependent upon an intact suture line, a return of its muscle belly to a normal state and the breaking away of the tendon from its surrounding tendon sheath. The latter of these three factors is the most important and the final outcome may not be evident until a period of three or four months has elapsed.

THE DANGER OF INFECTION ABOUT THE FACE

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THE complications which small furuncles around the upper lip and nares may produce are not generally recognized. In active hospital services one sees one or two deaths yearly from maltreated face infections. The fatalities do not result from medical procrastination, but from overzealous surgical intervention. It is essential to have a clear conception of the mode of spread of infection about the face before intelligent treatment can be instituted. The danger of the infection is producing a thrombophlebitis of the facial vein, with a resulting cavernous sinus thrombosis. Thrombosis of the cavernous sinus is nearly always fatal. Figure 1 shows the distribution of the venous blood supply about the face, and one sees a direct connection from the facial vein to the cavernous sinus. There is one area marked in heavy outline about the upper lip and nares which is the critical area of face infections. According to Dixon,[1] the factors which produce serious complications in this locality are four. First, early and frequent trauma. Second, absence of subcutaneous fat on the upper lip. Third, active muscular supply of this region. Fourth, the inability of the veins that drain this region to collapse. The most important factor seems to be the rich venous plexus, both superior and deep in relation to the muscles of the upper lip. Trauma causes the thrombi to be spread to the facial veins, with resulting cavernous sinus thrombosis in a high per cent. of cases. The danger zone of infection about the face can be roughly outlined as the area between the hair line of the forehead above and the chin below, with two parallel lines connecting this area at the outer wall of the orbit on each side. As can be seen in Fig. 1, all of this area has a venous drainage connecting with the cavernous sinus. To get a clear conception of the venous return of the face, I will quote from Gray.[3] "There are some points about the facial vein which render it of great importance in surgery. It is not so flaccid as are most superficial veins, and, in consequence of this remains more patent when divided. It has, moreover, no valves. It communicates freely with the intracranial circulation, not only at its commencement by its tributes, the angular and supraorbital veins, communicating with the ophthalmic vein, a tributary of the cavernous sinus, but also by its deep tributaries, which communicates through the pterygoid plexus with the cavernous sinus by tributaries which pass through the foramen ovales and foramen lacerum medium. These facts have an important bearing upon the surgery of some diseases of the face, for on account of its patency the facial vein favors septic absorption, and therefore any phlegmonous inflammation of the face following a poisoned wound is liable to set up thrombosis in the facial vein, and detached portions of the clot may give rise to purulent foci

in other parts of the body. On account of its communications with the cerebral sinuses, these thrombi are apt to extend upward into them and so induce a fatal issue."

The Treatment.—Furuncles about the danger zone of the face should not be traumatized by squeezing or small incisions. Needless to say numerous
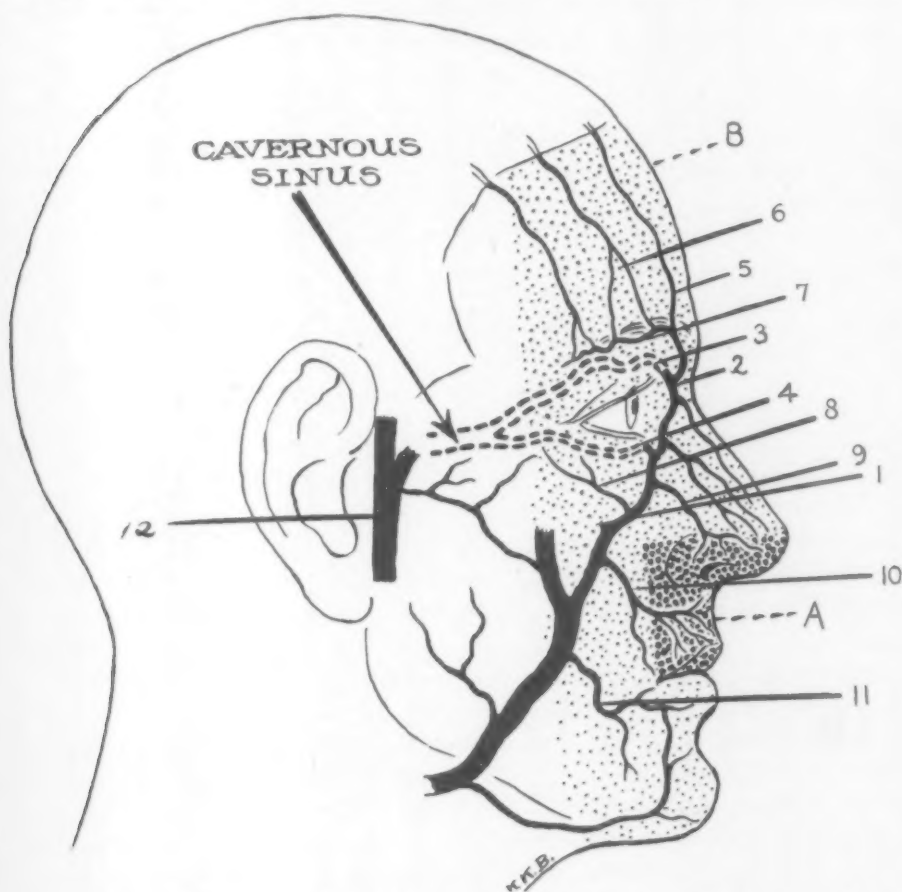
FIG. 1.—1. Anterior facial vein. 2. Angular vein. 3. Superior ophthalmic vein. 4. Inferior ophthalmic vein. 5. Frontal vein. 6. Supraorbital vein. 7. Superior palpebral vein. 8. Inferior palpebral vein. 9. Nasal vein. 10. Superior labial vein. 11. Inferior labial vein. 12. Temporal vein. *A.* Heavy dotted area around nose and upper lip is the "critical area" of face infections. *B.* Light dotted area is the danger zone for face infections.

furuncles about the face never lead to serious complications, but in those in which thrombosis of the cavernous sinus occur, the prognosis is fatal. Martin[2] states that every furuncle of the face and nose, and especially the upper lip, should be treated as if it might become a dangerous disease. It is best to treat all face infections conservatively. Heat is best used in the form of flaxseed poultices. This seems preferable to wet dressings. If the patient has chemosis, hot boric compresses may be applied to the eyes. The infection will usually localize with conservative treatment, and frequently will spontaneously perforate through the skin or mucous membrane, after which the

slough will be discharged through the opening. If the infection does not localize, an incision with a very sharp scalpel should be made, under general anæsthesia, without traumatizing the area. The wound should not be packed with gauze; but a rubber drain to hold the edges apart is all that is necessary. Hot poultices should be applied after the incision has been made. If the infection leads to a cavernous sinus thrombosis with meningitis, the only treatment that can be rendered is supportive measures.

CONCLUSIONS

1. Infections about the upper lip and nares will lead to cavernous sinus thrombosis in a certain per cent. of instances.

2. Trauma should be avoided in the beginning infection, particularly small incisions.

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ADENOMA OF THE THYROID*

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Much has been written during the past few years on the subject of adenoma of the thyroid in reference to its geographical distribution, symptomatology and treatment. The latter heading including prophylaxis, operative indications and technic, and recently the dangers from iodine therapy as in the excellent papers by Jackson[1] and others. The aspects of form and function seem to me to have escaped due discussion, certain terms and considerations, particularly in respect to form having persisted for many years.

In respect to form, there are first of all the two main types, the diffuse adenomatosis, described by Goetsch[2] and Else,[3] and the circumscribed, with single or multiple encapsulated masses. The encapsulated adenomata, possessing distinct vagaries as to form, have been classified as fetal or adult, colloid or cystic or calcified. A difference in time of onset of growth, having been ascribed as the cause whether a given mass were fetal or adult, an undue emphasis has been placed upon this detail. Similarly, whether or not a cyst were present, seems to have occupied the minds of many clinicians as of more importance than the fact that the patient possessed an adenoma of the thyroid.

Else discusses the origin of the diffuse adenomatosis from the so-called interstitial cells of Wölfler, but his arguments apply equally well to the same origin for the localized form. In the discussion of his paper on the relationship between the pathologic and clinical aspects of the diseases of the thyroid gland before the Section on Surgery, New York Academy of Medicine, Falk[4] stated that he had made reconstructions of glands with special attention to these interstitial cells and he found them to be separate and distinct groups not participating in the formation of an acinus, and by the same token not a few cells from the wall of an acinus lying in adjoining serial sections. Considering these cells as embryonic cells, robbed as it were of their birthright to participate in the normal development of an adult thyroid gland, we may predicate a development of them similar to what might be called the natural history of the cells in the normally developing gland.

Briefly, the embryology of the thyroid gland is as follows: Starting from the median anlage in the anterior wall of the primitive pharynx, and from the two lateral anlage in the fourth clefts, there occurs a downward growth from the former, and a forward growth from the two lateral ones to an eventual fusion, usually with obliteration of the median stalk, resulting in the two lateral lobes joined across the midline by the isthmus of the

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* Read before the New York Surgical Society, December 8, 1926.

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adult thyroid gland; a pyramidal lobe or thyroglossal cyst representing imperfect obliteration of the median stalk. The cells at first are grouped
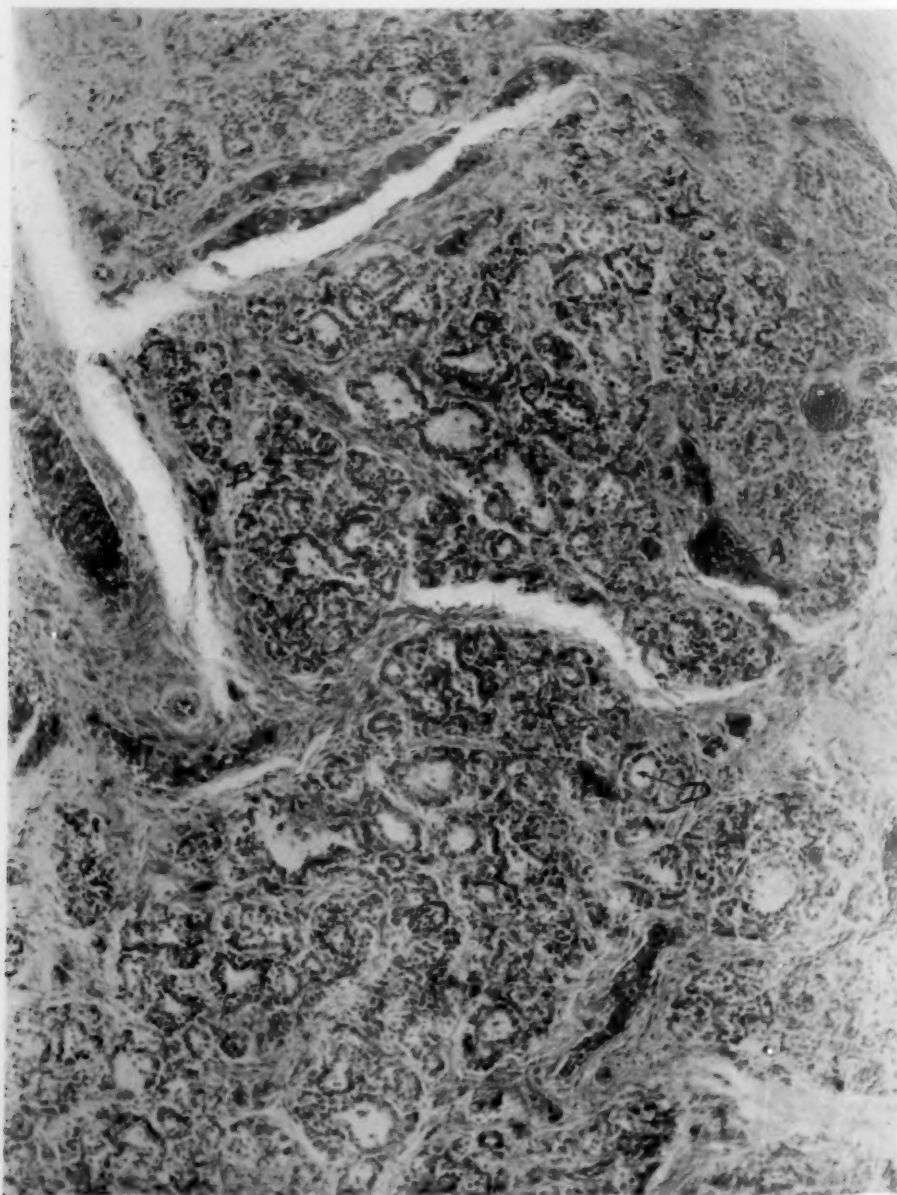
FIG. 1.—Seven months fœtal thyroid showing at: A, solid tissue, B, early cords and tubles, C, interstitial cells, D, small acini and colloid.

in a solid homogeneous mass. Later with the appearance of connective tissue and blood-vessels, solid cords are formed, cross-sections of which show a circular arrangement of the cells. These cords then obtain a small lumen, so that a distinct tubular formation is present. The tubules apparently are

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cut off at many points by connective tissue, and with the accumulation of colloid the adult acinar arrangement is finally obtained. A section of a seven months' fetal gland (Fig. 1) will show all of these stages, solid tissue, cords, tubules, small acini containing colloid, and here and there undifferentiated interstitial cells.

The same natural history, did it obtain in the growth of the interstitial cells, would give us tissue of different types, depending upon the stage of development or relative age of the adenoma. This seems to us the reason
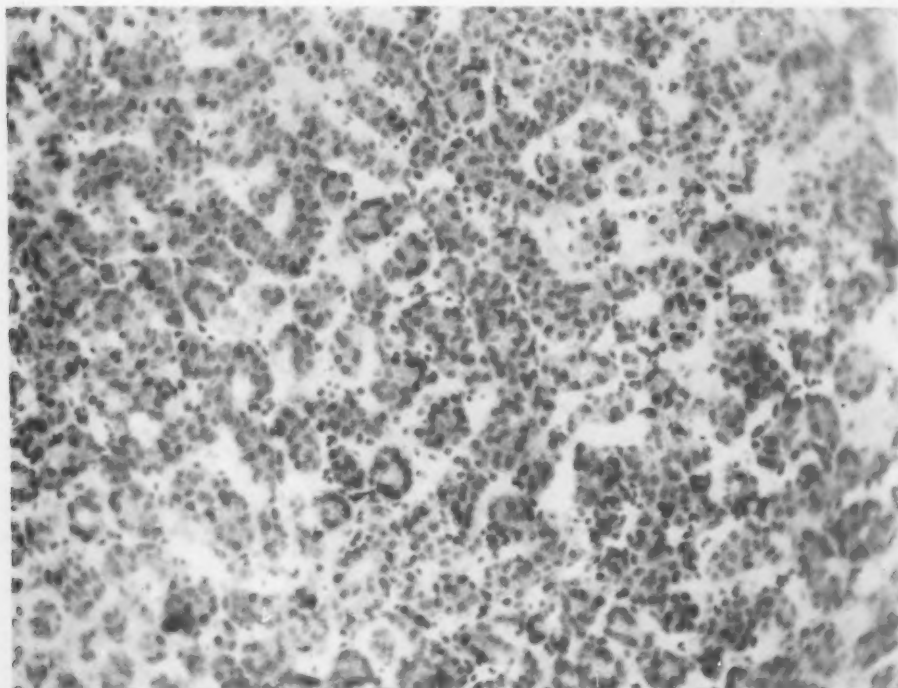
FIG. 2.—Adenoma composed of small tubules.

why such differences occur in the histology of adenomata of the thyroid (Figs. 2–6), a greater difference than occurs in similar tumors in other organs. Adenomata of the kidney, for example, are relatively standard tumors, but one finds adenomas of the thyroid composed of solid embryonic cells, of cords or tubules, others made up of acini apparently of adult normal gland architecture, some like colloid goitre, and others in which degeneration, hemorrhage, cyst formation or calcification have occurred. In many of these, differentiation from the normal or simple hypertrophy type is impossible microscopically, the diagnosis depending usually upon the gross finding of a distinct capsule. This encapsulation is more marked in the localized or circumscribed form, where the growing mass presses on the adjacent gland and causes atrophy. Fibrous replacement occurs, and thus successive layers of capsule are laid down at the expense of the gland tissue. In the diffuse type the encapsulation is ill defined early, perhaps due to a less rapid growth

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of the individual masses. We believe that a very large proportion of so-called colloid goitre is a late form of this diffuse type, the irregular lobulation with
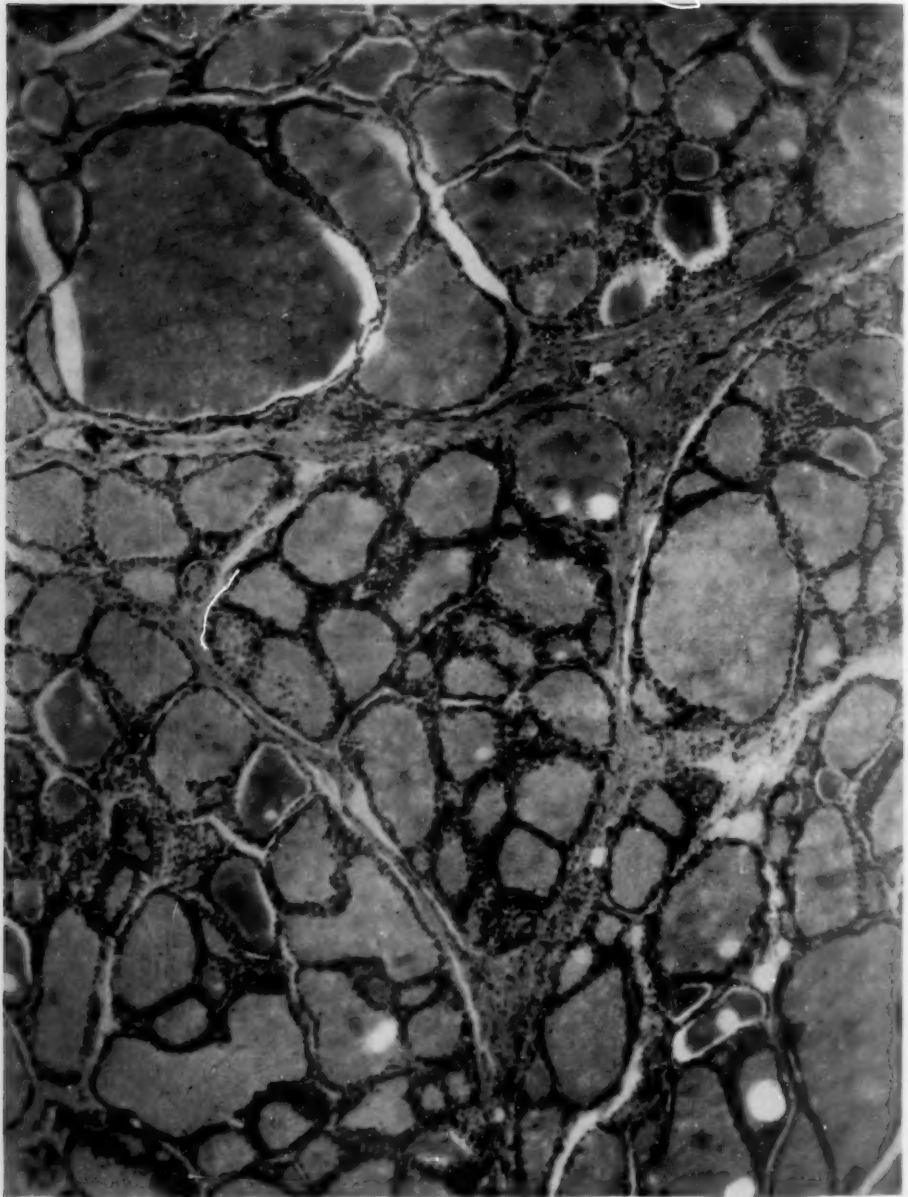
Fig. 3.—Adenoma resembling colloid goitre.

fibrous septa, representing different sizes of adenomatous masses that have all progressed to the colloid stage, with different thicknesses of capsule in proportion to the amount of pressure atrophy and connective-tissue replacement. This would restrict the diagnosis of colloid goitre to the group

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usually classified as simple hypertrophy of adolescence, a point of view clinically supported by the fact that so-called colloid goitre in the adult does
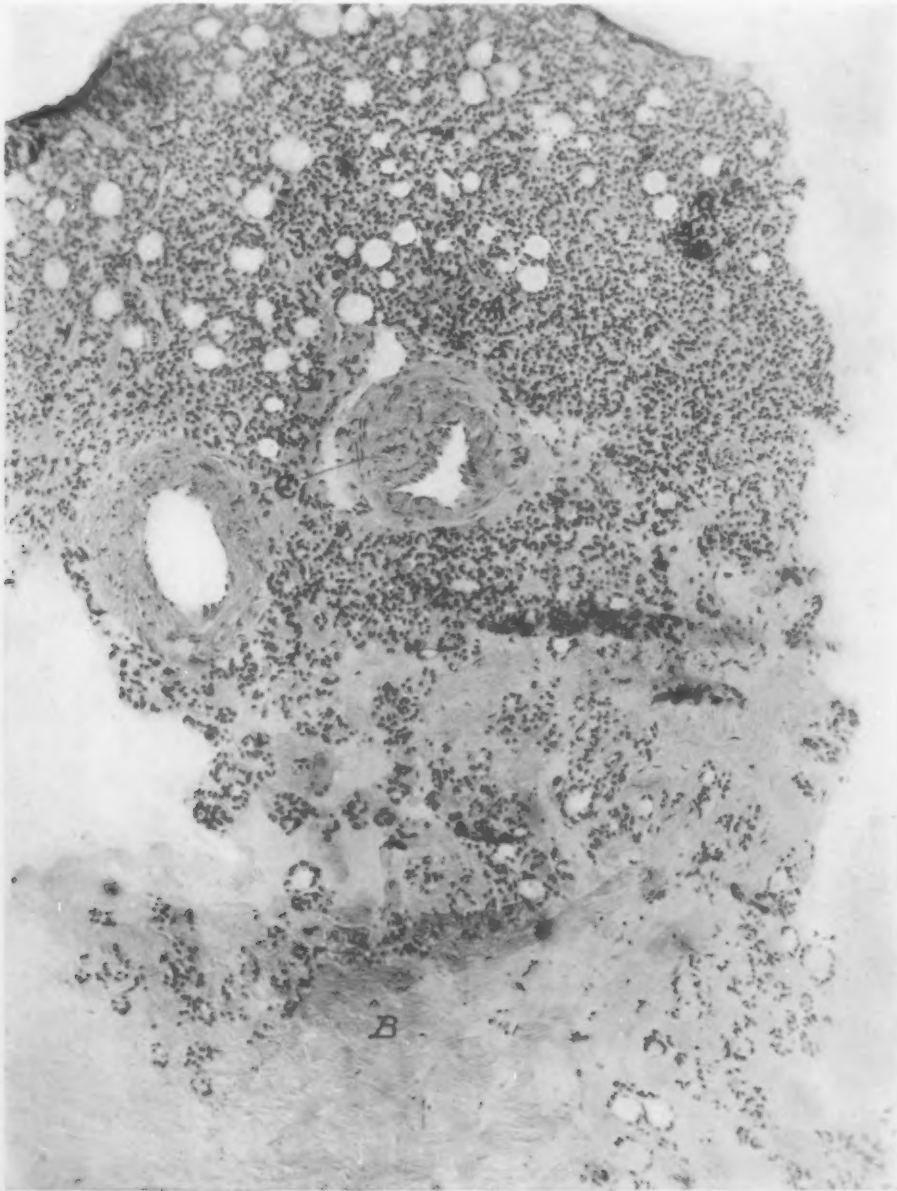
FIG. 4.—Adenoma composed of cords and tubules at A, showing degeneration at B, and thick-walled blood-vessels at C.

not respond well to iodine therapy, at any rate in a coastal region such as New York.

In discussing the aspect of function, we are up against an unsolved problem. Almost no adenomas are born toxic, many achieve it, and some

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seem to have it thrust upon them by injudicious iodine administration. Many individuals carry inactive masses throughout life. A large number,

FIG. 5.—Adenoma composed of solid tissue at A and solid cords at B.

usually in the late thirties, begin to have symptoms of hyperthyroidism, often without any noticeable change in their goitre. Furthermore, there is frequently nothing in the microscopical appearance of the specimen to differentiate it from an inactive mass. Usually the cells in the active type tend to a more columnar form, and the free margin may be somewhat fuzzy in

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appearance, but this finding is by no means constant. We have attempted mitrochondria studies in some of these cases, but without sufficiently satisfactory results to justify an opinion one way or the other.

The symptoms of adenoma with hyperthyroidism hardly require any

FIG. 6.—Capsule of adenoma with dense fibrous tissue at A, looser fibrous tissue at B, with compressed acini and degeneration at C.

further description. Plummer many years ago described this type as pure hyperthyroidism, differentiating it from the more complicated activity as seen in exophthalmic goitre, the symptoms of which the Mayo Clinic group, as well as many others, believe to be due to an altered and excessive rather than a simply excessive secretion of the active principle of the gland. That the adenoma itself does cause the symptoms seems proved by the prompt and lasting cure produced by the complete removal of only the adenomatous tissue.

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Where several adenomas occur some gland tissue as well must be taken, and in general it is better to do a bilateral subtotal operation in all cases in order to be sure of removing small, not readily palpable lumps. However, for the purposes of argument as to the activity of these masses, if one merely enucleates a single mass, and there results a complete cure from a very definite group of symptoms one is warranted in assuming that the particular mass removed was responsible for the symptoms. What the cause or causes may have been that spontaneously changed an inactive into an active adenoma is not known. Jackson [1] reported 38 cases in which the administration of iodine was associated with the onset of hyperthyroidism. This occurred in two of my cases two years ago, and I have seen two or three other cases that have received iodine from their private physicians. Fortunately my own cases were mild ones, but they served as good warnings as to the danger of giving iodine to adults with adenoma. The relationship between the spontaneous and induced type may not be as distant as it now appears when we learn more about the whole subject of iodine metabolism in relation to the thyroid gland in health and disease, and when we are able to explain some of the apparent inconsistencies in the action of iodine in exophthalmic goitre, in particular its most helpful but usually transitory effect.

One can be brief in the discussion of forms of therapy, for operation is the most successful one. It is of course indicated where pressure symptoms occur. In the inactive cases it is indicated not only for cosmetic reasons, but also as a prophylaxis against hyperthyroidism and malignancy.

We have no census tables as to the number of adenomas of the thyroid in the United States, and we can but guess at the percentage which become toxic. Inasmuch as about 40 per cent. of the cases of adenoma of the thyroid operated on at the Presbyterian Hospital in the past five years have had associated hyperthyroidism, and figures from other clinics also show a high percentage, it is fairly clear that hyperthyroidism may be expected in many cases. All writers on malignancy stress the probable preëxistence of adenoma, and this must also be considered as a possible danger, although we are again unable to quote the mathematical risk of any given simple adenoma becoming malignant.

Radiotherapy occasionally helps the hyperthyroidism of adenoma, but has no effect on the lump, and is far too unreliable to be depended upon. Operation offers a cure, and should be done as early as possible. The unsatisfactory results in our series are due mainly to two causes: Firstly, to recurrences because of incomplete operation, and secondly, to persisting cardiac symptoms, due to damage that had occurred prior to operation. The first of these can be avoided by better technic; the second by earlier operation. Real myocardial damage which occurs more often in adenoma with hyperthyroidism than in exophthalmic goitre, perhaps due to the greater average age of the individuals afflicted, is the main source of danger in this disease, not only in its relation to the interval results in the follow-up, but also as to the operative mortality. True post-operative hyperthyroidism is rarely seen in adenoma

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cases, but cardiac failure in the severe cases is much to be feared. Lahey [5] has called particular attention to this thyrocardiac group and their dangers, but has emphasized the possibilities in careful handling of these difficult cases. Thyroidectomy before the development of cardiac damage is as essential as appendicectomy before the development of generalized peritonitis.

A good exposure and a wide removal are, we believe, the two most important points in the operative technic. We seldom fail to divide both groups of preglandular muscles, as the time spent in their repair is more than made up by the greater ease of the procedure. Being content with simple enucleation of single masses in our earlier cases, we had several recurrences, but now do a bilateral subtotal operation unless the opposite lobe is as small and soft as one could desire. In the diffuse adenomatosis with hyperthyroidism, one is faced with the same problem as in exophthalmic goitre and one must leave as little active tissue behind as is possible. By closure of the capsule one can usually avoid drainage, but when this is necessary, as for a large dead space, it is better to have the drain emerge through the muscles on the side of the neck after careful closure of the muscles in the midline, thus preventing attachment of the scar to the pretrachial fascia, and also procuring more direct drainage.

Intrathoracic goitre should be operated upon under local anæsthesia, so that one may have the benefit of the patient's voice to give warning against division of the recurrent laryngeal nerve, and to minimize respiratory difficulty.

I wish to add my endorsement to Guthrie's [6] recent recommendation that Pemberton's technic be followed in these cases. Anyone who has suffered the tribulations of attempting to control inferior thyroid hemorrhage while the field was blocked by a large adenoma covering the retroclavicular space, and then follows his simple and logical technic, can appreciate his contribution to thyroid surgery.

CONCLUSIONS

1. Adenoma of the thyroid arise from the so-called interstitial cells.

2. The natural history of the cells of adenomata, whether circumscribed or diffuse, is the same as for the cells of the gland itself.

3. Operation is the best treatment for all adenomata of the thyroid.

4. Early operation is essential.

5. Iodine should be avoided in adult cases.

6. Pemberton's technic should be used for intrathoracic goitre.

7. Encapsulation is of more value in diagnosis than the microscopical appearance.

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THE VASOMOTOR REFLEX ARC

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THE following case report is of interest because of the light it throws on the sympathetic innervations of the blood-vessels.

J. C., white female, aged fifty-eight, entered the hospital, May 12, 1926, complaining of marked pain and swelling in the left arm. She gave a history that about eighteen months before she had had sudden shooting pains in the left breast. She then noticed that she had two small lumps about the size of walnuts in the lower outer quadrant of the left breast. A physician was consulted and local excision of the masses attempted. This was followed by the injection of some medicine into the remnant of the breast, which left a raw foul-smelling surface.

Four months later a radical excision of the breast and axilla was done. This was followed by X-ray treatment of the breast, arm, axilla and shoulder.

Some swelling of the fingers of the left hand was noticed soon after the operation. About nine months ago there developed a swelling of the entire upper extremity, beginning in the fingers and progressing upward. There was extreme lancinating pain, especially in the fourth and fifth fingers. Arm and hand have become progressively more swollen. Lately much more pain in the upper arm. Extreme aching at night which she describes as " just like a toothache."

Past negative except cholecystectomy many years ago.

Examination reveals a woman apparently about sixty, who is quite obese and well built, and is in excruciating pain. Nothing abnormal noted except left arm and chest. The left breast is missing. There is a scar running from the region of the xyphoid diagonally upward into the left axilla. This scar is loose and pliable. The subcutaneous fat on the anterior chest wall was not removed and there is every evidence of good wound healing. The entire left arm is enormously swollen. It pits deeply on pressure. The skin is tense and dry. This swelling extends on the chest wall both anteriorly and posteriorly. The anterior axillary border overhanging the scar consists of a series of swollen tags 5 to 15 cm. in diameter.

Careful search of the entire body shows no signs of metastatic carcinoma. No nodules can be felt on the chest wall or in the axilla although it is impossible to palpate the upper axilla on account of the œdema. The lungs are negative both to physical examination and X-ray. The long bones reveal no tender areas or X-ray defects.

Blood and urine normal.

Diagnosis.—Lymphœdema of the arm.

May 10, 1926; May 24, 1926. Pain has been severe. One and one-half grain morphine needed in twenty-four hours. For ten days the patient was kept in bed with the arm elevated in a perpendicular position. This was excessively painful and necessitated large doses of hypnotics, but there was no change whatsoever in the size of the arm.

It was thought that the removal of the arm was out of the question as the disease extended onto the chest walls. Alcohol injection of the nerve roots seemed dangerous on account of possibility of involving the phrenic. As any lengths were warranted to relieve the intolerable pain, it was decided to section the posterior roots of the entire brachial plexus.

This operation was done May 29, 1926. The first dorsal was ligated and cut first and the pupillary changes noted. Then the eighth, seventh and sixth cervical were ligated and cut and the fifth cervical crushed in a heavy clamp. The dura was closed

and the wound sutured in the usual manner. Subsequent neurological examination by Dr. George Hassin showed anæsthesia in the skin areas of these nerves. Horner's syndrome was present. The pain ceased to such an extent that morphine was no longer required, but an unpleasant feeling of heaviness in the arm persisted.

The remarkable feature was that *within forty-eight hours the lymphœdema had entirely disappeared from the hand and most of the arm.* Some swelling persisted about the shoulder and especially in the anterior axillary folds, probably the areas of the second dorsal and the fourth cervical which were not cut. The left hand was noticeably warmer than the right in spite of the apparent interference with the circulation. Extreme wrinkling of the deflated skin was seen. This condition persisted for about a week when the œdema began to recur and at the end of about a month, the arm was in the same condition as before the operation.

Summary.—Posterior root section in a case of obstructive œdema of the arm produced such extreme vasodilation that the œdema almost disappeared. This was a transient phenomenon and recurrence took place in about a month.

Discussion.—One is struck at once in this case by the exact similarity of the results to those obtained in periarterial sympatheticectomy. It seems reasonable to assume, therefore, that a very similar interruption in the reflex arc controlling vascular tone has been produced.

The exact paths of the efferent and afferent loops of the vasomotor reflex arc have been the subject of an enormous literature, which has received extensive additions in the last few years on account of the large amount of surgery done in this field. Jonnesco's and Jaboulay's earlier work has been brought to our attention again and the subject carried much further by the extensive researches of Leriche.[1,2,3,4] Most of the authors in this work take the view that when one does a periarterial sympatheticectomy, one cuts the motor nerves to the vascular walls, paralyzing them temporarily, and that, in the course of time, these rather primitive muscles have the power to assume an independent tonus in the same manner as the intestinal or cardiac muscle.

Wiedkopf[5] saw no reason to believe that there were any sympathetic afferents in the periarterial plexus. Ranson[6] says in concluding a résumé of our knowledge of this field, " It will be evident from the foregoing discussion that no satisfactory explanation of the hyperemia following periarterial sympatheticectomy has yet been presented." Leriche in a series of investigations does not arrive at any very definite conclusion but suggests that the sensory limb of the arc may be involved.

The difficulties in this field are much enhanced by the fact that in most experimental animals, especially in dogs, these changes, so striking in man, are almost totally absent. This fact has received beautiful experimental proof in the careful work of Lehman.[7] Leriche also agrees with these observations.

The opposite viewpoint has been admirably stated by Hahn.[9] * He believes that the results of sympatheticectomy are due to the interruption of

* What then is the mechanism of periarterial sympathectomy? Long centrifugal paths are not sectioned. . . . That any long centripetal nerves lying in the adventitia are thereby interrupted. By this means a great part of the centripetal path for vasoconstrictor tonus are interrupted, then this constrictor tonus is abolished, which is equivelant to a hyperæmia.

the sensory arc of a reflex. Cutting the sympathetics about an artery causes a loss of tonus due to the stoppage of afferent impulses necessary to maintain tone. This point of view seems far more rational as it is much easier to explain on this basis why the tone returns, when after a few weeks other sections of the afferent limb take over the work.

The observation of Krogh, Harrop and Rehberg [10] that stimulation of the ganglia in the sympathetic chain causes vasoconstriction could in itself be interpreted as a stimulus of either branch of the arc. Leriche and Policard [11] have, however, demonstrated that vasoconstriction is brought about by stimulation of the periarterial sympathetics. Bayliss [12] appears to have made the only observation on the vasomotor fibres in the posterior roots. He showed that stimulation of the posterior roots caused vasoconstriction.
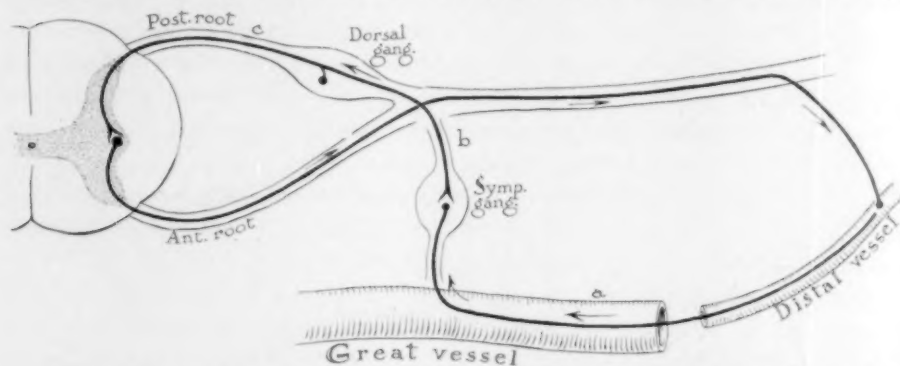
FIG. 1.—Diagram of the sympathetic reflex arc vasomotor control as postulated by the author. *A, B* and *C* represent the three points at which interruption of this arc brings about a very similar vasomotor effect. Point *C*, the posterior root, being obviously afferent it seems reasonable that points *A* and *B*, lie on the afferent arc.

Periarterial sympathectomy as is well known causes a temporary vaso-dilation of the corresponding limb. It is also well known that ramisectomy, the operation popularized by Royle and Hunter, produces an exactly similar result. The experience of many surgeons has shown that while its effect on muscular tone is exceedingly doubtful, the vaso-dilation produced is constant, evident and marked. The case reported adds a third point, that is, that section of the posterior roots produces an exactly similar effect, marked temporary dilation. It seems, therefore, perfectly reasonable to assume that in each of these cases we are severing the same tract at a different level as the effect seems to be so similar. One cannot possibly believe that the posterior roots contain any but sensory fibres, and therefore, the conclusion is justified that the entire tract which is covered by these three types of operation is a sensory one.

What then is the course of the vasomotor reflex arc? Potts [13] and Kramer and Todd [14] have shown that numerous sympathetic fibres reach the vessels in their more distal portions directly from the spinal nerves. This is especially true in the skin. It is well known that stimulation of distal segments of spinal nerves causes vasoconstriction and here we are dealing with a motor stimulus. We may assume that the efferent vasomotor tracts leave the spinal

cord in the anterior roots and gain access to the vessels through the spinal nerves, reaching the smaller branches or more distal portions of the larger trunks below the level at which sympatheticectomy is ordinarily performed. The afferent limb follows upward in the adventitia of the artery until it gains entrance to the ganglia of the sympathetic chain, entering the cord through the posterior roots. Langley [15] has made it clear that the afferent limb of this arc in all probability consists of at least two neurones, synapsis probably occurring in the sympathetic ganglion and in the posterior root ganglion as well as many cases. (See Fig. 1.)

This assumption also does away with the necessity for assuming two sets of nerves to the vessels, constrictors and dilators. Interruption of one or the other limb in the reflex arc can produce any of the various phenomena which have been noted in this connection.

Finally it may be noted that this case also shows clearly that there are afferent sympathetics in the cervical region. The absence of white rami in the cervical region has been noted by Ranson [16] and others. Vogt [17] describes the nucleus sympatheticus lateralis superior as extending upward including the eighth cervical. Even in the absence of white rami, it is clear from the results in this case that afferent fibres must be included with the efferent in the gray rami.

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MALIGNANT GROWTHS OF THE THYROID*

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THE whole conception of malignant growths of the thyroid was enveloped in considerable mystery until recent years. Even now many features are uncertain. Three factors have been responsible for this confusion.

1. The apparent rarity of malignancy in this organ has resulted in a somewhat limited opportunity for clinical and pathological observation and classification.

2. The histological pictures vary to an astonishing degree, so that even well-trained pathologists often find it difficult and even impossible to determine whether a goitre is or is not a malignant growth from the study of tissue sections.

3. A careful follow-up as a means of determining the true condition in doubtful cases has been generally neglected.

Sixteen malignant growths of the thyroid have been observed at the New York Hospital in recent years. I am indebted to Dr. John Rogers for the records of five of these. Since the object of this paper is to analyze what may be done by surgery, the results in these cases are presented:

Fourteen Carcinoma. Post-operative.—Five died within 8 months, local extension or metastases. Three died in about 3 years, metastases. Two lost in 1 and 2 years, respectively, but presented local recurrence. One post-operative death. Three apparently well but less than one year after operation. Two sarcoma (lymphosarcoma). These died within 8 months, local extension.

Many other cases have enacted considerable discussion as to the possibility of malignancy. These have been carefully studied by the pathologist and clinician, but no doubtful case has been listed as malignant. They include those cases of adenoma in which the pathologist reported histological evidence of malignancy but no recurrence occurred.

On account of the uncertainty which often exists in pronouncing certain cases of goitre as malignant, it is well to review what is meant by malignancy.

Ordinarily the term implies immature or embryonic type of cell; rapid growth; peripheral extension, with infiltration of the surrounding tissues; tendency to develop metastases; tendency to central degenerative changes; liability to local recurrence after removal and systemic manifestations as cachexia (Adami).

These qualifications, however, cannot be unreservedly applied to malignant growths of the thyroid.

Attempts to classify the various types of carcinoma of the thyroid result in artificial and confusing tables which serve no useful purpose. Classifications as given by Langhans and Kocher are not appropriate on account of

* Read before the New York Surgical Society, October 27, 1926, and the Interstate Post-Graduate Assembly, October 21, 1926.

transition of one group into another. It is sufficient for our purposes to appreciate certain broad subdivisions.

Carcinoma may originate in the thyroid parenchyma; in an adenoma; or in aberrant thyroid tissue.

Carcinoma originating in the thyroid parenchyma may show histologically an extremely lawless cellular growth with all the evidences of extreme malignancy or the type may be an adeno-carcinoma or papillary adeno-carcinoma, with little to suggest malignancy. These neoplasms follow the tendencies of growth and invasion which are noted in carcinoma elsewhere. The growth invades the thyroid to a variable extent, even crossing the isthmus to the other lobe, ultimately reaches and infiltrates the capsule of the gland and infiltrates adjacent tissues, notably the trachea. In contrast to malignant growths originating in adenomata, metastases occur mainly by the lymphatics, the regional nodes being first involved.

Carcinoma originating in an adenoma has recently excited much discussion and the study of this lesion has added greatly to the knowledge of malignancy of the thyroid. The subject demands somewhat extensive consideration.

An adenoma is a definite tumor formation. It is a round or oval circumscribed encapsulated mass within the thyroid parenchyma. In many cases multiple adenomata are present. Their structure is not uniform; they may present various types of tissue, notably embryonal, fetal or adult. The fetal is the most common and consists, in general, of concentrically arranged cells with no apparent lumen; the embryonal type shows an even less differentiated structure, while the adult presents acini with lumina containing colloid and conforming more or less closely to the normal thyroid structure. An adenoma often presents combinations or variations of these types; and often shows strands of cells without apparent coördination or arrangement. It is at once evident after observing such histological pictures how difficult it may be to recognize malignancy from the study of tissue sections.

These growths illustrate the doctrine of Ribbert of the unicentric growth of tumors, that is, growth occurs at the periphery and the most mature or central parts undergo degenerative processes which lead to secondary changes of fibrous, hyaline, or calcareous character. Central necrosis and hemorrhage often lead to the formation of cysts.

Carcinomata originating in adenomata are at first limited by the capsule of the parent tumor. When the growth has penetrated this capsule its progress is like that of a cancer originating independently of an adenoma. In a certain proportion of cases malignancy within the adenoma may be recognized microscopically by the morphology and arrangement of the cells. These characteristics may be confined to small areas or may be widely spread throughout the adenoma. In other cases grave doubt persists even after careful study; the cellular arrangement appearing lawless but nothing other than this feature suggesting malignancy. The recognition of invasive properties of the tumor, which is the best evidence of malignancy, is particularly

difficult in this organ when the growth has not passed beyond the normal capsule or the capsule of the adenoma. Irregularity in size of nuclei and cells ordinarily suggests turbulent growth, representing one of the factors embraced under the term anaplasia. But this feature is of far less significance in the growths of the thyroid than in malignant tumors developing from other glandular structures. In these doubtful cases Graham urges the importance of determining whether there is invasion of the blood-vessels as evidence of malignancy.

Graham's contribution will prove of great value if his interpretations prove correct. He concludes that the morphological character of the cells and tissue is an unreliable basis for the determination of malignancy of thyroid tumors; that their malignancy depends upon their tendency to invade adjacent tissues and that the most constant single indication of thyroid malignancy is invasion of the blood-vessels.

He states, further, that epithelial tumors that are encapsulated and show no invasion of the blood-vessels are benign, irrespective of their microscopic appearance.

From a practical viewpoint it must be emphasized that the examination of an adenoma for blood-vessel invasion is a somewhat prolonged procedure. It is not comparable to a rapid frozen section of a bit of suspected tissue, for instance, in the breast. It can therefore only be employed by a careful study of the tissues after the operation has been completed. In other words, it has a bearing upon prognosis but not upon the operative procedure. We have never been able to find true vascular involvement, although tumor cells have been found occasionally in spaces containing blood-cells.

In the Mayo Clinic from 1910–1916, 1.6 per cent. of goitres exclusive of exophthalmic were classified as cancer (Balfour). Over 80 per cent. of the patients were over forty years of age and the larger proportion were women. In almost all of the cases there was a long preëxisting goitre. This supports Graham's statement that 90 per cent. of malignant tumors of the thyroid originate in adenomata.

While we must accept the evidence that cancers of thyroid are preceded by, and develop in, adenomata in a large proportion of cases, there is no convincing evidence as to proportion of adenomata which become malignant.

Careful analysis suggests that possibly undue weight is now being attached to the probability of cancer developing in an adenoma. As one reviews the conditions which existed three to four decades ago when goitre operations were unusual and patients harboring adenomata did not in general accept surgical intervention, one is impressed by the fact that few cancers of the thyroid were noted, indeed far fewer than would have been seen if adenomata presented the marked tendency to malignancy which is at present generally assumed.

It may well be that undue importance has been attached to the finding in blood spaces or even in definite vessels within an adenoma of tissue of the same structure as that of the adenoma. The vessel walls of an adenoma are

extremely thin; they rupture and erode readily, as is shown by the tendency to hemorrhage in the central portions. The apparent presence of tumor tissue within vascular spaces might represent non-malignant extension or might be an artifact due to handling or cutting the tissues. Definite invasion of the vessel wall or growth of tumor tissue along the intima should be recognizable to be convincing as to the malignancy of the adenoma.

An obvious argument in favor of the possibility of non-malignant extension within the vessel is the long-accepted teaching that non-malignant metastases, especially in bone, occasionally occur in. association with the growth of a simple goitre. This impression which was originated by Cohnheim half a century ago has been unquestioningly accepted by most of his followers, but has been attacked recently, notably by Bérard and Danet.

They state that Wolfler examined the sections in Cohnheim's case and found evidences in the thyroid suggestive of malignancy. They also analyzed a number of reported cases bearing upon this subject. For instance, in 1910, Vellot published a case of a man of sixty-eight from whom a tumor in the lumbar region was removed, which presented the structure of the thyroid gland. The thyroid showed only a very small nodule which did not increase in size during the subsequent fifteen months. Yet, recurrence of the metastasis occurred and the patient died after a second operation. Examination of the thyroid then showed a small encapsulated apparently benign adenoma which, however, in one area on microscopic section showed what was considered typical carcinoma. Crone in 1914 published similar cases. On the basis of such observations the authors consider it necessary to revise the views bearing upon so-called benign metastases from simple goitres. They consider that a metastasizing goitre is a malignant goitre, and deny the fact that thyroid tumors differ in this respect from the general rules bearing upon the evolution of new growths. Simpson reaches the same conclusion, namely that there is no such entity as a benign metastasizing goitre.

The difficulties encountered by the pathologist in determining the existence of malignancy in this organ must be emphasized. Frequently the whole gland is diseased and cancer develops only in one portion. The pathologist should therefore receive all the tissue removed at operation, fresh and unfixed. When the tissue has been fixed its texture and color are changed and it is more difficult to recognize suspicious areas. As already stated, the recognition of invasive properties of the tumor is usually difficult and the occurrence of irregularity in size and arrangement of cells and nuclei has less significance than in other organs.

The careful pathologist no longer relies in tumors of the thyroid solely upon the histological picture. A correct diagnosis is best ensured by consideration of the clinical course, careful inspection of the gross material in recent state in conjunction with examination of sections from suspicious areas or, in the absence of such areas, from many portions of the gland. Coöperation between the surgeon and pathologist is essential.

A careful review of the evidence, then, indicates, that—

1. Most malignant growths of the thyroid originate in preëxisting adeno-mata; the incidence of such development is, however, uncertain.

2. The histological picture often is not conclusive either for or against malignancy.

3. True vascular invasion is a conclusive criterion of malignancy. This feature, however, is difficult to recognize.

4. The long-accepted teaching that metastases occur from benign goitres is unsupported by facts.

Metastases.—There are certain characteristics in regard to thyroid metastases to which attention should be called. Lymphatic invasion is more frequent in carcinoma originating in the parenchyma, blood-vessel invasion is more frequent in carcinoma originating in adenomata.

Whereas metastases may develop in bones or viscera, there is a striking tendency for their occurrence in bones. Mammary carcinoma alone equals carcinoma of the thyroid in the frequency of bone metastases. The metastases in bones may be multiple or solitary. In some the primary focus remains latent, and the metastases dominate the clinical picture, the original focus presenting nothing of clinical significance to attract attention to it.

A metastasis is usually of relatively slow growth and may appear to be a solitary tumor for a considerable period.

It is generally believed, on the basis of v. Eiselberg's case, that a thyroid metastasis may function similarly to the apparently normal thyroid gland and act vicariously for the thyroid. Yet, this is at variance with one of the precepts in regard to malignancy; that malignant cells do not function. In v. Eiselberg's case total thyroidectomy was followed by myxœdema and tetany. These persisted until a metastasis developed in the sternum. Four years later the metastasis was removed and myxœdema recurred.

I will omit discussion of carcinoma in aberrant thyroid tissue as well as the symptoms and course of the disease, except to state that the course is relatively slow and death occurs from the effects of the infiltration of adjacent structures or as the result of metastases.

Diagnoses.—In early cases of carcinoma, especially those originating in an adenoma, there are no clinical features to suggest the diagnoses. Balfour, in discussing the clinical aspects, states that in only 18 per cent. could a positive diagnosis of malignancy be made clinically. In 46 per cent. malignancy was not suspected before operation. He stresses the fact that the cancer lies concealed within the thyroid for some time before reaching the surface or undergoing systemic dissemination.

The development of a mass or tumor in the neck, or more frequently, increase in the size of an existing goitre, is usually the first feature to attract the attention of the patient. The growth is always progressive with no periods of regression. Irregular and nodular surface; firm, even hard, consistency, are usual with malignancy. In some cases, dysphagia, dyspnœa, hoarseness and radiating pains are the first features observed by the patient. These signs always indicate that the neoplasm has already passed beyond the

thyroid, and are therefore late symptoms. Errors have occasionally arisen in: Chronic thyroiditis and strumitis, tuberculosis or syphilis of the gland or hemorrhage into a cyst. But in such doubtful cases, a careful history and physical examination will usually readily clear up the diagnosis. The so-called iron struma or Riedel's thyroid, however, may occasion confusion. In this, dyspnœa due to compression of the trachea is the outstanding symptom. Although the thyroid is extremely hard and fixed, it may be differentiated from malignancy by the fact that it does not show progressive growth; in fact, since the late stage represents a replacement fibrosis of the thyroid parenchyma, it is not associated with any increase in the size of the gland.

Treatment.—Carcinoma in and confined to an adenoma must be considered independently. And this is the feature upon which emphasis should be laid, because it offers conditions favorable for treatment. Experience has shown that a large percentage of thyroid cancers begin in adenomata, many of them in adenomata of long standing; that for a considerable period no clinical evidence indicates the fact that carcinoma has developed; that the histological picture is often not typical. While careful study of the tissues may demonstrate the malignant nature of the lesion, recurrence is often the first indication of it. Not infrequently this has occurred in relatively young individuals, even as early as the third decade.

It is evident that a rapidly growing adenoma, especially in middle life, must be regarded with suspicion and should be treated as malignant. The proper procedure in these cases is resection of such portions of the thyroid as contain adenomata. This may include parts of both lateral lobes and isthmus. Such a procedure is relatively easy and free from danger.

Multiple adenomata in general demand resection; solitary adenomata, especially non-toxic, may be enucleated. These procedures are referred to here since they may be regarded somewhat in the light of prophylactic measures, namely, the removal of potentially malignant tissue.

Considering the relative infrequency of cancer of the thyroid, it seems unwise to alarm a patient by the suggestion of malignant potentialities. While the removal of adenomata should be urged, the probabilities of the development of toxic symptoms are a sufficient argument in most cases to ensure consent to operation.

Carcinoma originating in the parenchyma, or secondarily involving the parenchyma by extension through the capsule of an adenoma, constitutes the type of carcinoma which was exclusively recognized before the significance of adenomata as the favorite nidus for cancer growth was appreciated. Under these conditions the cancer is diffuse and infiltrating and since its clinical evidence is at first obscure, it often reaches an advanced stage before aid is sought and before the true condition is appreciated by the surgeon.

Unfortunately when the diagnosis of malignancy is definite the case is usually beyond the possibility of cure by surgery. If the growth has penetrated the capsule of the thyroid and has invaded the adjacent tissues, even radical operation can accomplish nothing. Suspicion of malignancy,

therefore, is the indication for operative interference. It is to be regretted that little aid in clearing up the uncertainty can be obtained by examination of frozen sections since the histological appearance varies so much and so rarely offers a typical picture that reliance must be placed chiefly on clinical criteria. While radical operation is interpreted as complete or almost complete removal of the thyroid, it is obvious that decision as to such a step must be difficult. If the lesion is confined to one lobe, especially if it is not assuredly cancerous, the other lobe naturally should not be completely removed. On the other hand, if the case is unquestionably one of cancer, generally both lobes are involved, the capsule has been penetrated and adjacent tissues invaded. Under such conditions complete removal of the thyroid will subject the patient to discomfort and risk without offering hope of a radical cure. Therefore, while total extirpation of the gland is theoretically the proper procedure, it is only rarely indicated because in cases of limited extent it is too much and in advanced cases it is too little.

That opinions differ in regard to total extirpation of the thyroid is evidenced by contrasting the views of various surgeons. Thus, Von Eiselberg and Kocher preserved a piece of the gland; Kausch recommended complete extirpation and Sudeck performs total extirpation when he operates at all; but he claims remarkable results with Röntgen irradiation. He therefore operates on no case in which metastases are demonstrable or where the tumor has invaded the neighboring tissues.

Operative Results.—In Balfour's report there were 65 per cent. operative or early post-operative deaths from the disease. The late results of the remainder are still uncertain. The great majority of apparent cures occurred in those cases in which the malignant change was an unexpected finding. Total thyroidectomy was rarely performed in this group. In most instances the lobe containing the tumor and the malignant process was removed, but in many the enucleation of an adenoma was the procedure.

Irradiation.—In view of the uncertainties of operation in advanced cases, irradiation must be given serious consideration. Most radiologists agree that carcinoma of the thyroid is remarkably sensitive to radiation.

One might summarize what has been said somewhat as follows:

Removal of adenomata is the best means of treating cancer of the thyroid. It constitutes a prophylactic procedure.

If carcinoma is discovered after the removal of an adenoma, thorough post-operative radiation is indicated.

Cancer not limited to an adenoma is rarely cured by surgery.

When the clinical diagnosis of cancer is definite, irradiation is in general preferable to bold efforts at radical extirpation.

Sarcoma.—Sporadic cases of sarcoma have been reported. Since the thyroid contains in its stroma considerable connective tissue, there is no reason why sarcoma should not occasionally develop therein. Yet the epithelial tissue is vastly in preponderance and is a highly functioning epithelium. Therefore the relative frequency of sarcoma might well be expected

to be small. The differentiation from carcinoma in an individual case offers difficulty by reason of the great variety of forms which carcinoma may present. Ewing states that the occurrence of sarcoma, implying by this definite evidence of mesoblastic origin of the tumor, still requires demonstration. No detailed consideration of sarcoma is possible since the rare individual cases which undoubtedly occur have not been grouped and excite discussion chiefly in the effort to prove or disprove that they are sarcomata. But in most cases the discussion leaves even this feature in doubt. Yet DeQuervain states that all varieties of sarcoma occur in the thyroid.

His views represent the prevailing impression and teaching.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held October 4, 1926

The President, Dr. CHARLES F. MITCHELL, in the Chair

GASTRIC TETANY

Dr. W. HAROLD STORM, by invitation, reported from the service of Dr. A. P. C. Ashhurst, at the Episcopal Hospital, the case of a man, forty-one years of age, who was admitted to the hospital August 23, 1926, with the history of a recent attack of acute appendicitis recurrens.

On admission there was well-marked rigidity over the right lower quadrant, and though no mass could be felt and peristalsis was audible, and the patient did not appear ill, immediate operation was decided upon.

At operation, August 23, 1926, an adherent gangrenous appendix was enucleated from a small abscess cavity and removed. Four hours later, before complete recovery from anæsthetic, he had a very peculiar spell. There was fixity of position of extremities and his eyes had a wild stare. This condition lasted about an hour. No epileptic history. On the day following operation he complained of very severe gas pains and was given an asafœtida enema and rectal tube and was relieved. Passed gas and voided.

The following day he again complained of distention, which was only partially relieved by enema. Fairly comfortable during night. At the end of forty-eight hours, on August 26, the distention became worse during the day and was not relieved by an enema. Eserin sulphate, gr. 1/40, given hypodermically and repeated in an hour, gave some, but only temporary relief. Enema brought no relief.

On August 27, the patient presented the clinical picture of threatening acute intestinal obstruction. Peristalsis could only be heard faintly at long intervals. Rested more easily towards noon, but at 2 P.M. complained a great deal of the distention, which was extreme. There was no pain. At 6.30 P.M. patient could be heard groaning from a distance. He had his arms extended, wringing his fingers and crying out with pain. Had a very anxious expression on his face and was vomiting foul-smelling material. Enemata gave no relief, but morphine and gastric lavage seemed to afford some relief. Continuous enteroclysis and morphine ordered and nothing by mouth. Patient rested fairly well after 9 P.M. and had no more pain.

After two days of much relief, he developed, August 30, a violent diarrhœa. Towards evening ne had spasmodic convulsive seizures in which he threw his arms out from his sides and shrieked with pain and said he could not breathe because of a feeling of oppression beneath the sternum. Upper abdomen ballooned up (stomach) and then went down with eructations of gas by mouth. Temperature, 102°. Convulsive seizures were quite frequent, but occurring at irregular intervals. These seizures continued during the next twenty-four hours.

The blood was tested for chlorides, calcium, and CO_2 content; and the urine for chlorides. Bl. calcium, 10.01 mgms. per 100 c.c. blood (normal is 10-12 mgms. per 100 c.c.). Bl. CO_2 combining power, 70.8 volumes

9   129

per cent. (normal is 60–83 volumes per cent.). Bl. chlorides, 200 mgms. per
100 c.c. blood (normal is 450–500 mgms. per 100 c.c.). Urinary chlorides
as NaCl, 0.5 gm. for 1000 c.c. urine. An intravenous injection of normal salt
solution (750 c.c.) was given at 11 A.M. At about 1 P.M., 250 c.c. of 15 per
cent. solution of sodium chloride was given intravenously. During the
administration of the hypertonic sodium chloride solution patient had a very
severe convulsion, resulting in the displacement of the needles in the vein and
spilling some of the solution into the subcutaneous tissues. This convulsion
was by far the most severe of all. Eyes diverged, face looked as if it were
being torn to pieces, both upper extremities went into a convulsive seizure.
During none of the convulsions were the lower extremities noticeably
involved. A duodenal tube was passed at 3 P.M. The man had no more
convulsions after the intravenous 15 per cent. sodium chloride. The dis-
tended stomach went down after the passage of duodenal tube. Gastric
analysis of one specimen from stomach (taken just after lavage) showed no
free hydrochloric acid and only 25 total hydrochloric acid. During night he
had severe diarrhœa but rested fairly well. Was fed cocoa, milk, orange
juice, lemon juice, etc., every four hours, by duodenal tube, getting 250 c.c.
each time. There were no more convulsive seizures, and on September 1, his
condition was much improved, abdomen soft, stomach not distended, no
vomiting, and diarrhœa checked. Convalescence was further complicated by
the development of a pulmonary inflammation which is suspected to be
tuberculous. He is still in the hospital.

Dr. A. P. C. Ashhurst remarked that the patient whose history had
been presented by Doctor Storm is one of the complicated cases of appendi-
citis which is mentioned in his paper on " The Mortality in Appendicitis."
This man survived. He was very sick at the time and Doctor Ashhurst
believes that he was made very much worse by eserin. He had a gangrenous
appendix, lying in a mass of adhesions. For tympanitis three days after
operation he was given a dose of eserin, causing too active peristalsis in the
presence of a subsiding peritonitis and this in turn caused an intestinal kink
and partial obstruction.

The first time he had used eserin was in a case of typhoid perforation with
successful suture. After three to six days the patient became very much
distended and a dose of eserin was given. The distention went down but
the patient died, and at autopsy a second perforation was revealed. Since
then he has been afraid of eserin in peritonitis. We should always remember
that the patient is not sick because he is distended, but is distended because
he is sick; the treatment, therefore, is not to reduce the distention, but to
treat the sickness.

In the case reported by Doctor Storm, by washing the stomach and giving
morphine, the patient was tided over the period of distention. Because of
the obstruction the hydrochloric acid was not getting out of his stomach to be
absorbed in the small intestine and this probably caused alkalosis. The
patient's state was so very serious that he decided to give him hypertonic salt
solution intravenously, which was done, and the patient got well.

Dr. John H. Jopson recalled a case reported before the Academy about
a year and a half ago from his service at the Medico-Chi Hospital, which

was one in which typical gastric tetany was observed following operation for a large inguinal hernia where the man vomited repeatedly after the operation. A Jutte tube was used to relieve him. The function of the Jutte tube is to relieve distention of the upper intestinal tract. Of the people that it keeps alive, a number are liable to develop alkalosis unless measures are taken to prevent it by hypodermoclysis of salt solution. Another case now convalescing is the third he has seen. This is a woman of thirty-nine who had incomplete intestinal obstruction. Operation revealed carcinoma of the ascending colon, for which resection of the terminal ileum, cæcum and ascending colon was performed. Acute dilatation developed on the second day and was relieved by the Jutte tube. She was all right for ten days when dilatation of the stomach again developed, due to adhesions around the pylorus. After treatment for several days with the Jutte tube, the patient became dehydrated and developed the typical symptoms of alkalosis. In view of her greatly dehydrated condition, glucose was administered intravenously in connection with hypodermoclysis. Four hundred c.c. of a 10 per cent. solution of glucose and continuous hypodermoclysis were given the first day with prompt relief of the tetany and the next day 500 c.c. of a 25 per cent. solution. Re-operation then relieved the adhesions around the pylorus. She made a good convalescence thereafter.

MORTALITY IN APPENDICITIS

Dr. A. P. C. Ashhurst read a paper with the above title, for which see page 89.

Dr. George P. Muller said that Doctor Ashhurst's paper brings up the perennial discussion; and he does well to emphasize that the mortality is in the group of cases where abscess and gangrene and diffuse peritonitis are present. Two years ago Doctor Muller reported one year's work and yesterday he analyzed the past year's work. In neither one were there any deaths in acute appendicitis where drainage was not employed. Many of these cases were classed as peritonitis, i.e., there was turbid fluid in the abdomen which when cultured showed microörganisms. Therefore, the problem is—as Doctor Ashhurst has said—in the drained cases.

In the past year he drained 36 cases and had 4 deaths, a mortality of 11.4 per cent. That is a high mortality. The total mortality for the whole group was 3.4 per cent. As compared with the year previous, when he showed 50 drained cases with 5 deaths (10 per cent.), there is an increase of 1.4 per cent., but actually the percentage of drained cases was less, because they now close more cases without drainage.

Guerry, of Columbia, S. C., published a paper in the Annals of Surgery for last August in which he gives his results for 25 years, showing a total mortality of 1.1 per cent.—688 cases with one death. The speaker had no deaths in two years in cases which were not drained. In the remaining cases he has a mortality of 2.1 per cent.—(664 cases) and in the group of cases—not diffuse peritonitis cases—the mortality was 1.7 per cent.

The difference in mortality as reported by various writers makes one wonder whether the 10 per cent. mortality is not too high. It leads one to question one's procedure. There is the question, how long shall one delay operations in these cases? A recent patient, fifty-five years of age, with a mottled abdomen, was placed on enteroclysis, Fowler position, etc., and seemed greatly improved; this was at 4 P.M., and he died the next morning. Autopsy showed the peritoneal cavity swimming with turbid fluid. He might have been better handled by decompression. The difficulty is to know what to do with persons who are terribly ill. He had had a number of operations on the third day, during which time the patients have had nothing by mouth. There is always the danger of throwing these patients into alkalosis. He used to think that the thing to do was to individualize the patient, and that it was better not to have a time schedule, as the delay in some patients might be six hours and in others two days. So far he had had nine deaths; five one year and four the next. Why does one have a mortality of 10 per cent., when Guerry only has 1½ per cent. to 2 per cent.? One does not have enough cases to solve this question in one year or even two.

BENIGN BONY ENLARGEMENT OF THE CONDYLOID PROCESS OF THE MANDIBLE

Dr. Robert H. Ivy read a paper with the above title, for which see page 27.

Dr. George P. Muller called attention to an error in technic which he made the year before last in connection with this incision. He was removing the loose cartilage from the joint; it was easy to expose and to remove, but at the time he encountered some hemorrhage in the lower angle of the wound in trying to reach the vein, and urged the assistant to retract harder, so that he could examine the bleeding and stop it. The day following the operation the patient showed all the signs of facial paralysis. This was distressing, as the patient happened to be an actress. In three months' time, however, this disappeared with the exception of an inability to wrinkle the forehead, which is still the case. She was able to close her eyes, etc., and by wearing her hair over the forehead she is able to conceal the fact that she is unable to wrinkle it. The dragging down to look at the vein was sufficient to give enough injury to cause the palsy.

CARCINOMA OF THE THYRO-GLOSSAL DUCT

Doctors Hubley R. Owen and Helen Ingelby reported the following case history: A woman, age forty-five years, was admitted to the Woman's College Hospital, Philadelphia, on September 21, 1925. Her chief complaint was swelling of her neck of three years' duration. No history of cancer in the family. Has been married for twenty-seven years. One child (deceased). She first noticed a swelling of her neck three years ago—very small in size, about the size of an almond. The tumor apparently began in the midline and extended to the left. This tumor grew slowly until one year ago when the growth became more rapid. Has never had any difficulty breathing or swallowing. She has noticed no hoarseness, undue perspiration,

palpitation or dyspnœa. Claims to have lost about ten pounds in weight in the past year and has felt decidedly weaker. No history of insomnia. Appetite is good. Menstrual history normal.

From the midline of the neck in the region of the thyroid cartilage, extending to the left of the midline, there is a tumor the size of a hen's egg. It is not attached to the skin. There is no inflammation of the skin. The general consistency of this tumor is hard. There is, however, one soft area about the size of a walnut which apparently fluctuates. The tumor is not tender. It apparently moves with deglutition.

September 23, 1925, Doctor Owen, through a collar incision about three inches long, exposed the mass, which appeared to be cystic. Rupture occurred while attempting enucleation; cystic and colloidal matter escaped into the wound. The capsule of the tumor extended up to the hyoid bone beneath the sternum and beneath the sterno-hyoid muscle. It was impossible to remove the entire capsule, but as much as possible was tied and severed. Part of the stump of the capsule was left above and part below the cystic portion of the tumor.

March 1, 1926, the patient was readmitted to the hospital with a recurrence at the site of the operation. The size of the present tumor was about two centimetres in diameter, slightly to the left of the midline of the neck. The tumor was round, hard and adherent. A second operation

FIG. 1.—Part of the cyst wall (low power) showing aggregations of lymphocytes. Thick-walled vessels are visible. The dark spots are engorged vessels.

was performed March 2, 1926, through the scar of the former operation. Two small tumor masses were dissected out, one cystic; the second a hard fibrous mass. Both were attached to tracheal rings.

The excised portion of the cyst removed at the first operation had a wall varying in thickness from 0.5–0.3 mm. and was irregularly loculated. There were several low projections on the inner surface. Microscopically the wall consisted of parallel bands of fibrous tissue in which were embedded dense masses of lymphocytes. Some of these closely resembled lymphoid tissue, i.e., they showed fairly defined reticulo-endothelial cells surrounded by lymphocytes. Others, especially the small perivascular groups, were clearly of inflammatory origin. The inflammation extended into the surrounding muscle which was infiltrated by small round cells and, in many places, invaded by fibrous tissue. The blood-vessels were thick-walled and for the most part dilated. Here and there in the cyst wall small vesicles lined by cuboidal cells were seen. Their structure recalled that of the thyroid, but they contained no colloid. Although not typical, they were interpreted as rudimentary thyroid vesicles which are often seen in the walls of branchiogenic and thyroglossal cysts. No characteristic epithelium could be found lining the cyst.
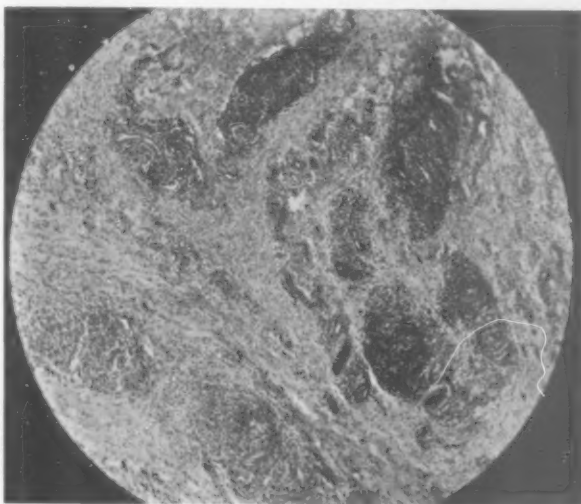
This was hardly surprising in view of the size of the cyst and the inflammation of its walls, but it is unfortunate as it prevents exact diagnosis.

The diagnosis made at the time was that of branchial or possibly thyroglossal cyst. The grounds on which this conclusion was based were: (a) The characteristic fibrous tissue wall; (b) the presence of lymphoid tissue; (c) the presence of rudimentary thyroid tissue. The lymphoid tissue may have been formed simply in response to the invasion by carcinoma cells and the rudimentary thyroid vesicles might be interpreted as a part of the growth. Nevertheless, it is clear that a cyst existed for some considerable time before the malignant growth. Had this been a cyst of the thyroid gland itself, it seems impossible that thyroid tissue should not have been found in its immediate neighborhood, but none was present. Its situation and character do not correspond to any form of cyst and therefore we adhere to the original diagnosis of a cyst derived from embryonic rests, probably from the pharyngeal pouch corresponding to the third branchial cleft, i.e., the thymopharyngeal duct.

FIG. 2.—High power view of tumor showing the formation of papillæ.

The pieces of tissue removed at the second operation microscopically revealed a typical papillary adenocarcinoma. The growth consisted of cuboidal cells with pale vesicular nuclei and irregular, ill defined, often vacuolated protoplasm. The cells sometimes formed vesicles which did not contain colloid. More often they had a papillary arrangement around a central core of connective tissue. Occasionally a number of these papillæ were contained in one large vesicle (Fig. 2). In a few areas the tumor cells had become much more irregular and stained very deeply, suggesting added malignancy. A severe inflammatory reaction was present and numerous polymorphs in all stages of degeneration were found among the tumor cells. Lymphocytes were also found in abundance. Lymph-glands, as well as areas of less well-defined lymphoid tissue, and the surrounding connective tissue were invaded by the growth. No normal thyroid tissue was seen.

DOCTOR OWEN remarked that this case raises the question of the origin of papillary adenocarcinoma in the thyroid region. If one follows the teaching of the standard text-books, it is generally considered to arise in the gland itself, but in this case the thyroid appeared perfectly healthy. The tumor was found at the site of the previous operation and at the actual spot where a portion of the cyst wall had been left behind. One must therefore assume an origin from the wall itself.

It seemed just possible that they were dealing with a carcinoma of the thyroglossal duct. But in vain had he searched the literature for any record of such a phenomenon. He had come across no single description of any malignant tumor arising in the thyroglossal duct or from a thyroglossal cyst. Delafield and Prudden[4] suggest that a squamous-celled carcinoma might develop in such a situation and one other author mentions the possibility,[5] but none describe an actual growth. Nor could he find any example of a papillary adenocarcinoma arising from a branchiogenic cyst. In all the recorded cases the tumor is squamous-celled. Some other origin for our tumor had to be sought.

As long ago as 1857 Schlüter[12] described a somewhat similar growth in the side of the neck which had no connection with the thyroid and which he supposed to be derived from an accessory thyroid gland. Madelung,[10] Jores,[7] Kapsammer[8] and others describe papillary adenomas and carcinomas which they all attribute to accessory thyroids. A very able account of these tumors has been given by Billings and Paul.[2] They have collected and analyzed all the recorded cases (34 in number) of aberrant thyroids and the growths arising from them. Papillary cyst-adenoma and carcinoma have been reported fifteen times. Some of these bear a fairly close resemblance to our tumor. Three authors, Kapsammer, Barker[1] and Hinterstoisser[6] describe partly cystic tumors, the cysts having fibrous walls as in our case. They do not, however, mention the presence of lymphoid tissue in them. Kapsammer's case is particularly interesting for he gives a figure of his tumor, which seems identical with ours except that it was much larger. His tumor was adherent to the thyroid gland, but had otherwise no connection with it.

If one studies these authors a good case is made out for affirming that this type of papillary adenoma or adenocarcinoma always arises in aberrant thyroid tissue. It would seem to originate but rarely, if ever, from the thyroid itself and never from midline embryonic structures such as thyroglossal rudiments. But in this case if one supposes such an origin is to be explained away the cyst which was certainly present before the carcinoma, and in which the carcinoma began. Of course cysts may and do arise in aberrant thyroids, but in that case one would expect to find colloid-containing vesicles grouped somewhere in the wall. The vesicles in the sections were extremely sparse, were never arranged in any kind of group, and none contained colloid. It might be held that the carcinoma had produced the cyst, but in view of the history and the findings at the first operation this seems scarcely tenable. He fully admits that the histological character of the cells suggests a thyroid origin rather than an origin from embryonic rests, but the clinical course of the tumor points in the reverse direction. He therefore proposed a compromise. He would suggest that tumors of this type take their origin not from the lining epithelium of the branchial or thyroglossal cysts, but from the rudimentary thyroid tissue present in their wall. This satisfies the histological conclusions of Kapsammer and Jores, with which he was in

agreement, and at the same time accounts for the situation and mode of growth of these tumors and the microscopical findings in the cyst wall.

It would be absurd to draw any final conclusions from the study of one case. He brought this material forward in the hope that others will be tempted to follow up the question and look for preëxisting embryonic rests in patients with papillary adenoma or adenocarcinoma of the thyroid.

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POST-OPERATVE MASSIVE COLLAPSE OF THE LUNG

Doctors W. P. HEARN and LOUIS H. CLERF read a paper with the above title, for which see page 54.

DR. ISIDOR RAVDIN said that from the Brigham Clinic in Boston, Doctor Scott has reported the entire literature on this subject. There is a definite mortality. The cases he had had all got well without bronchoscopic treatment. He had one patient with complete massive atelectasis following operation for chronic appendicitis. He was extremely ill for five or six days. He thought he was too ill to take the chance of any bronchoscopic treatment. The patient got well and in fifteen or sixteen days was ready to leave the hospital. This condition is frequently confused with pneumonia. If the patient shows signs of pulmonary complications, look at the location of the apex beat. It is always deflected toward the affected side in collapse of the lung.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 13, 1926

The President, DR. WALTON MARTIN, in the Chair

OBLITERATIVE ENDOANEURISMORRHAPHY FOR TRAUMATIC ANEURISM

DR. HAROLD NEUHOF presented a man, now thirty-three years old, who accidently sustained a perforating wound of the left thigh by a 45-calibre bullet eight years ago. The entry wound was in the lower part of the thigh on its inner aspect, the exit was in the upper part of the popliteal space. After a few days' rest in bed the patient was able to be up and about without symptoms. Two to three weeks after the accident he noticed a pulsating swelling in the popliteal region. The mass gradually enlarged to reach "the size of a plum," after which it remained stationary. At no time were there well-defined symptoms referable to the swelling. Occasionally there was a sense of heaviness in the limb or a tired feeling after a day's work, but the patient was able to pursue an active occupation without discomfort.

Seven days before admission to the hospital there was a sudden seizure of severe pain in the left calf while the patient was walking about. The next day the pain extended to the left foot and toes. Pain grew progressively worse, soon incapacitating the patient. He was unable to sleep for five days before admission to the hospital because of pain. Discoloration of the big toe and then of the second toe was noted two days before admission, the foot and calf became swollen and bluish.

On admission the left leg from the knee down was enlarged, cool, generally bluish and mottled. There were scattered purplish red areas that were more numerous towards the ankle and foot. The first three toes were entirely blue and colder than the remainder of the foot, with necrosis of the skin over the great toe and a beginning patch of gangrene on the second toe. The veins of the calf and foot were deeply engorged. A typical aneurism about 12 cm. long, 6 to 7 cm. wide, occupied the popliteal region. Faint pulsation was to be felt in the dorsalis pedis and posterior tibial vessels at the ankle.

Operation was performed directly after the patient was seen at the hospital, for it was evident that the gangrene already present in the toes would be rapidly progressive if relief was not given. It appeared to be justifiable to attempt some form of vascular repair, reserving amputation if that did not succeed.

The sac was found to be generally fusiform in shape, the posterior wall globular. Branches of the popliteal nerve were noted along its lateral aspect. The wall was in part greatly thinned out. The contents of the sac were a large old thrombus, partly adherent to the deep surface, recent clots, and fluid blood. The aneurism appeared to be a purely arterial one. The mouths of the popliteal artery were towards the floor of the sac and were widely separated.

The operation was done with the application of an Esmarch bandage, a procedure which did not appeal to the reporter but was employed to save time at this emergency procedure. A free vertical incision was made. Avoid-

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ing the nerves the sac was entered, its contents evacuated, and the two openings of the popliteal artery were shut off from within the sac by chromic gut sutures. The excess of the sac was ablated and the interior then obliterated by three superimposed tiers of chromic gut sutures.

The day after operation the foot and calf were warm, and there was less cyanosis of the toes than before. Except for the blackness of the first three toes the circulation returned fully to the foot and leg in about ten days. The patient left the hospital, walking in comfort, three weeks after operation. He returned two months later for partial amputation of the second toe, the dry gangrene having persisted. There was as well a superficial necrosis of the tips of the first and third toes. These wounds healed in the course of several months. Six months after operation the patient could walk two or three miles in comfort, complaining of pain in the calf after walking greater distances. It is now more than two years since operation. There is no recurrence of the aneurism. Circulation in the leg is normal, although pulsation in the arteries at the ankle cannot be felt. The patient's occupation involves walking long distances, sometimes ten miles a day, which he can do without any symptoms referable to the left leg.

The symptom-free end result in this case in which the popliteal artery was obliterated and reliance placed on the collateral circulation is in striking contrast with the result of a successful embolectomy done in a man whom he also presented. In this contrasting case, an embolus was removed from the popliteal artery about three hours after the onset of symptoms. The embolus was presumably derived from the mitral valve, the cardiac lesion being one of mitral stenosis of several years' standing. There was prompt return of circulation after the embolectomy and normal pulsation of the popliteal artery and of the arteries at the ankle has persisted. Nevertheless, there are frequent attacks of pain and vascular spasm in the extremity. It is assumed that they are due to the scar of operation in the popliteal artery.

Dr. Robert T. Morris discussed the possibility of a new channel having been constructed in the popliteal aneurism. Doctor Morris had done this once in preference to following the Matas method of closure of the lumen. There had been no leakage in this case and no interference with circulation excepting while the tourniquet was on but the aneurism occurred a year or so later and required ligation.

RESECTION OF STOMACH FOR LYMPHOSARCOMA

Doctor Neuhof presented a man, forty years of age, whose history, he said, and particularly the X-ray findings, offered some suggestive data on the duration of lymphosarcoma.

The symptoms in this man began two years ago. They consisted in pain in the left upper abdomen and eructations of gas. Pain was never severe, and there were intervals of several weeks in which the patient was free from symptoms. A striking feature was the absence of progression in the symptoms. In fact, the patient felt so well at the time of operation that he desired to postpone surgical treatment.

About six weeks after the onset of symptoms a series of gastric X-ray pictures were taken. They indicated clearly the existence of a small ulcer at the greater curvature of the stomach in its mid-portion. Another series at a later date demonstrated the same lesion. A final set taken shortly before operation showed no difference from the original series taken a year before by the same röntgenologist.

The only positive findings in the physical examination was the vague

outline of a mass in the epigastrium. This in addition to the X-ray studies led to the decision to operate, even in the absence of symptoms suggestive of a progressive or of a grave lesion.

At operation, the greater curvature of the stomach was found to be the seat of a soft irregular mass spread as a placque in its wall. Its limits were not well defined. The transverse diameter was about 6 cm., the vertical, extending into the lesser omental sac, was 4 to 6 cm. In the centre of the mass a small ulcer was felt. Under the impression that the lesion was a simple ulcer of the greater curvature with a surrounding inflammatory reaction, a midgastric resection was done. The lines of resection went wide of the mass at the greater curvature and converged to a limited resection of the lesser curvature. Five layer anastomosis with catgut sutures was employed. The specimen disclosed a punched-out ulcer through the mucosa with a clean base at the muscularis. Its margins were elevated, soft, and continuous with the surrounding tumor mass. The latter occupied and partly invaded the muscularis. The neoplasm did not invade the serosa and reached the mucosa only at the ulcer. The microscopic examination revealed a typical lymphosarcoma, the margin of the ulcer being composed of tumor tissue. The lymph-nodes that were removed were not involved.

The post-operative course was smooth. A series of deep X-ray treatments were given. It is now six months since operation. The patient weighs more than he did before operation and is free from symptoms. An X-ray examination of the stomach indicates approximately normal peristalsis with slight delay in emptying time.

DR. CHARLES L. GIBSON spoke of two cases at the New York Hospital, showing sarcoma of the stomach. The first, a male, age twenty-eight years, operated on July 5, 1921, for a perforating sarcoma of the stomach, made a good recovery and was seemingly in good condition for over a year, dying seventeen months after operation. The pathological diagnosis was myosarcoma. The second, a male, age thirty-four years, had pylorectomy performed in April, 1920, for pyloric obstruction. When last seen a year ago he was in excellent condition, had gained much weight and looked and felt exceedingly well. In this case the examination of the gastric contents showed free HCl 68; total acid 90. The pathological diagnosis was lymphosarcoma.

LATE RESULT OF TRANSPLANTATION OF TOE FOR MISSING FINGER

DOCTOR NEUHOF presented a child who came under observation in Mount Sinai Hospital in July, 1922, when she was seven years old. Deformities of the fingers of both hands were noted at birth, and also fusion of two toes of the left foot. The hands were useful for ordinary purposes. The right hand presented an interesting problem for improvement of the deformity and of function. The thumb, fourth, and fifth fingers were normal. Only the proximal phalanx of the index finger with its thickened surrounding tissues was present. The middle finger was totally absent, a short stump of the proximal phalanx, about a centimetre long, projecting beyond the head of the metacarpal bone. The plan was to transplant the second toe of the right foot with part of the metacarpus in the form of a pedicled graft. The metacarpus and adjacent tissues were to be included in order to supply the necessary length. A few days before operation a plaster-of-Paris mould was prepared to hold the child in position with the right knee flexed and the right arm extended downward in front of the body.

At operation the stump of the missing finger was first prepared. The

overlying skin was reflected as a flap with its base on the ulnar side. The shell of proximal phalanx, found to be of cartilaginous consistency, was exposed and its end freshened. The stumps of the flexor and extensor tendons of the missing finger were exposed and dissected free for a distance of about 2 cm. A wet pack was put in place and dissection of the foot begun. This consisted in an incision across the web between the first and second toes and extension of the incision over the dorsal and plantar surfaces of the foot. The head of the second metacarpal and the flexor and extensor tendons of the second toe were isolated and were divided about 1.5 cms. back of the head of the bone. The tissues on the lateral aspect of the second toe were not disturbed, so that the toe with adjoining metacarpal bone and tissues swung on a thick pedicle with undamaged lateral nerve and blood supply. The hand and foot were then brought together by rotating the right leg and bringing the shoulders forward. More difficult was the problem of adjusting the fingers to the foot. The thumb and second finger were placed on the dorsum of the foot, and the fourth and fifth fingers over the sole of the foot. After the hand and foot were placed and held in position, the stump of the finger was approximated to the pedicled toe. A suture of chromic gut was passed through the shell of the phalanx of the missing finger and through the metacarpal bone and tied without tension. The ends of the extensor and flexor tendons of toe and finger were approximated with fine silk. The margin of the skin flap of the finger was sutured to that of the toe. Immobilization in plaster-of-Paris casing.

In recovery from the anæsthetic the child struggled and the plaster shifted. Some separation of the skin was noted on the third day, and it was necessary to use adhesive straps to maintain approximation of the skin. The circulation in the pedicled toe remained good.

The detachment of the toe was carried out fifteen days after the first operation. An incision was made across the web between the second and third toes and extended wide of the second toe, so that there would be more skin than was necessary. The space in which the dissection was made was cramped and the tendon anastomoses were damaged when the toe (with adjoining metacarpal tissues) was completely detached. It was necessary to remove much of the fat pad on the plantar surface and part of the metacarpus of the transplant because these structures made too pronounced a prominence for a cosmetic result. The skin margins were trimmed and sutured.

The circulation remained good in the graft from the outset. The wound healed by primary union for the most part. Sensation was first noted in that part of the graft nearest the finger stump about three weeks after detachment. It advanced in ring-like fashion and sensation was normal about six months after operation.

There were never any symptoms referable to the transplanted toe. About six weeks after operation it appeared certain that the tendon sutures had not held. Every effort was made to have the parents consent to send the child to the hospital for resuture, but I was unable to obtain their consent. The first winter after operation the transplanted toe was colder and more bluish than the adjoining fingers in cold weather. These manifestations have disappeared since that time. The only disturbance in nutrition of the grafted toe is to be noted in the nail. This grew irregularly at first. Now it grows smoothly but more slowly than the normal, and the free margin of the nail breaks off from time to time. The function in the transplant is limited to movements transferred to it by the adjoining stump of the finger and separate motions can only be anticipated if the tendons are sutured or a tendon transplant performed. The X-ray pictures show not only survival of the phalanges,

but also indubitable evidence of increase in length and thickness. This is most clear in the proximal phalanx of the grafted toe. At no time after operation, in a period of a year during which numerous X-ray pictures were taken, was there any evidence of absorption of the phalanges with bone replacement, the phenomenon that I had anticipated. There has been and there continues to be a slowly progressive increase in the length and thickness of the transplanted toe. Four years have elapsed since the transplantation has been done and there is therefore every reason to expect permanent survival of the graft. The cosmetic result is satisfactory but not of course ideal for a transplanted finger would alone fulfill all the requirements.

CARCINOMA OF ASCENDING COLON

DR. CHARLES L. GIBSON presented a man, aged twenty-five years, who had been subjected by him to appendectomy in January, 1925, and to right herniotomy and hemorrhoidectomy in October, 1925. From the date of the latter operation his health was poor and he lost flesh and strength and suffered a good deal from abdominal pain and increasing constipation.

When admitted he looked acutely ill and very anæmic. Two-inch scar to right of umbilicus. To the right of the scar there was a hard, irregular mass, somewhat larger than a fist, evidently in the colon. Bismuth picture of colon showed a persistent filling defect of colon. Prior to operation a blood transfusion was done.

At operation, June 11, 1926, a carcinoma of ascending colon was found. A resection was done with line of section through the ileum, a foot from the valve and the middle of the transverse colon. Anastomosis end-to-side with Murphy button, Murphy button being introduced through the suture line of the colon and made to protrude through the gut by Carle and Fantino technic.

He had a difficult convalescence. Two weeks after operation another 800 c.c. transfusion given, after which improved rapidly. Discharged on the twenty-sixth post-operative day in excellent condition.

It is now four months since operation. He has gained fifty-nine pounds in weight.

DOCTOR GIBSON said that he presented this case to show the disadvantages of an appendectomy through a small incision, not allowing of proper exploration. For some years he had both practiced and preached that every operation for chronic appendicitis should be an exploratory operation.

There is every reason to think that the tumor was present at the time of operation and was the source of the symptoms for which an appendicitis was mistaken.

He called attention to the advantages of the technic used in this case—a fairly rapid and satisfactory operation—the use of the Murphy button for end-to-side anastomosis between the ileum and large intestine. The large intestine is closed by running suture of catgut of the mucous membrane first. The last two or three loops are left loose allowing of the dropping of the button into the lumen of the gut, the suture then is pulled tight. Then follow the two other layers of sutures. After the colon has been closed the shank of the Murphy button is made to protrude very close to the line of closure. It is very important to have no dead space in the closed colonic end. The Murphy button so employed is readily introduced, is absolutely safe and easily passes into the small intestines.

CANCER OF TONGUE

Dr. George H. Semken presented two patients who illustrated different methods of operation in cancer of the tongue anterior to the vallate papillæ, in which the primary tumor has apparently not extended beyond the limits of the tongue.

The first patient, a woman, aged thirty-one, came under observation December 29, 1924. Two months previously, she had noticed a small lesion under the left side of the tongue, which apparently had been caused by the sharp edge of one of the lower teeth. The lesion was an irregularly elliptical ulcer, 1.5 cm. in its long diameter, with considerable induration at its base. It caused no discomfort except on contact with food. The submaxillary lymph-nodes on both sides were slightly enlarged, but those on the left more markedly. The family history showed no known antecedent cases of cancer. The remaining previous history was irrelevant; and the Wassermann reaction was negative. No etiologic factor for cancer, other than the sharp tooth, could be found.

The operative procedure in this typical case was planned to remove the lesion and its presumable extensions in the tongue, together with the regional lymph-nodes as charted by Küttner [*Beitr. z. klin. Chirurgie*, 1898, vol. xxi, No. 3, p. 732]. This involved the removal of the left half of the tongue with part of the left hyoglossus and genio-glossus muscles, all the lymph-node groups on the left side of the neck, the lymphatics of the upper half of the right side of the neck and those of the submental space. The operation was done in two stages. On January 2, 1925, the submental and upper right-sided neck dissection, and the intra-oral left hemi-glossectomy were done; and on January 30, 1925, the dissection of the left side of the neck followed. The pathological laboratory examination of the specimens showed squamous-celled carcinoma in the tongue and hyperplasia alone in the lymph-nodes. The present anatomical and functional conditions are good.

The second patient, a man, aged sixty-one years, came under observation April 5, 1926. He had had a coated tongue and occasional soreness since three or four years, but no lesion had been noticed until about six weeks previously, when a nodule of pin-head size appeared on the dorsum of the tongue at the tip. The nodule broke down, leaving a small hole, and this excavation became progressively and rapidly larger. At about the same time (relatively) a mass appeared on the right border of the tip, and this also increased rapidly in size. Both lesions were very painful. At the time of examination he had a midline, hard infiltration in the tip of the tongue, 3.0 x 2.2 cm. in diameter, with a longitudinal excavation 2.0 cm. long, 0.7 cm. broad, and 1.2 cm. deep which reached to the under surface. The floor was clean and red. In addition, he had a nodular infiltration in the right edge of the tongue, 1.6 x 1.4 cm. in diameter, near the tip. It extended through the whole thickness of the tongue and showed on the dorsum as a fungoid, rounded projection with spots of yellow and gray. The chief node of the right submaxillary group was enlarged and hard. The family history showed no known antecedent cases of cancer. He had been an excessive pipe smoker and formerly also chewed tobacco. He had had syphilis thirty-five years previously, but was Wassermann negative. The previous history otherwise was irrelevant.

Under treatment with potassium iodide, he seemed to show some improvement, but this was soon followed by an increase in the extent of the lesions, with evidence of considerable and destructive invasion. The midline lesion, 3.5 x 1.3 cm., split the tongue and gave it a forked appearance, and its floor

became fungoid and necrotic. A similar advance was noted in the lesion in the right edge.

The operative procedure in this case consisted in the removal of the tongue to the zone just posterior to the vallate papillæ with the hyoglossus and genio-glossus muscle, all the lymph-node groups on the right side of the neck, the submental group, and the upper lymph-node groups of the left side of the neck. This operation also was done in two stages. On April 29, 1926, the lymphatics of the upper half of the right side of the neck and of the submental space were removed, the lingual artery was tied, and the hypoglossal nerve and the lingual branch of the fifth nerve were divided. The anterior tongue was then excised through the mouth, together with as much of the hyoglossus and genio-glossus muscles as could be removed by this route. On June 5, 1926, the operation was completed by the removal of the upper left cervical lymphatics, and the remaining (supraclavicular) lymphatics of the right side of the neck. The pathological laboratory examination of the removed tissues showed squamous-celled carcinoma in both lesions of the tongue and hyperplasia in the lymph-nodes. The present anatomical and functional conditions are good.

DOCTOR SEMKEN said that in hemi-glossectomy for cancer certain technical points deserve emphasis: (1) If the line of section is exactly median, the remaining half of the tongue will have a relatively sharp, long, narrow, tip, which has little mechanical value, and which is constantly traumatized by the anterior teeth against which it impinges. It is preferable, therefore, to extend the incision across the tip of the opposite (healthy) half so as to include enough of its tip in the excised tissue, to leave a rounded end on the remaining tongue tissue. (2) If the line of section is exactly median, also, it will go through the raphé and may fail to remove some of the small lymph-nodes situated in this part of the tongue. This danger is obviated by carrying the longitudinal line of section along the opposite half, slightly to the side of the median line. (3) In order to include as many large trunk lymphatic vessels of the tongue as practicable, the decussating lymphatic plexus about the apex of the vallate papillæ is included by having the line of section sweep around that point; and, further, in suitable cases, the lower pole of the tonsil of the same side and the tissue just below it, are included in the tissue removed. (4) The removal of as much of the hyo-glossus and genio-glossus muscles as can be done from within the mouth is designed to include the possible extrinsic extensions of cancer in that direction, as shown by Cheatle (*Practitioner*, 1905, vol. lxxv, No. 5, p. 623), and others. (5) An important measure of safety is the preliminary destruction of the surface of the cancerous ulcer with the actual cautery, to guard against possible re-implantation of cancer during the operation, especially by trauma from the gauge wipes. (6) The landmarks on the tongue, floor of the mouth and fauces are readily visible under ordinary conditions, but become obscured by even a small amount of blood in the mouth and throat. This obscuring of the landmarks tends to make the lines of incision uncertain, and too little or too much tissue may be removed or the cancer field itself may be entered. To guard against this uncertainty, a series of black silk suture guides may be inserted at landmark points before the operation

is begun. These will remain readily visible in spite of blood and mucus; and incisions carried around the line of guide threads, so as to leave them all attached to the tissue that is removed, will safely circumscribe the intended field of excision. (7) In the few cases in which the lymphatic dissection in the neck is done on the same side as that of the cancer of the tongue at the primary operation, the ligation of the lingual artery of that side reduces the bleeding during the hemi-glossectomy. In the typical procedure, however, the upper lymphatics of the opposite side are removed in the first stage, and it is not safe or desirable to ligate the lingual artery of the healthy side. As an effective alternative measure, a catgut ligature may be placed around the external carotid artery of the healthy side, just distal to the superior thyroid branch. This is left untied, with the long ends emerging between sutures of the closed neck wound; and the angulation closure of the external carotid by traction upon these long ends during the incisions in the healthy half of the tongue gives the required control of the bleeding in that area. The ligature is withdrawn at the end of the operation and the artery remains uninjured. In sectioning the remaining tongue substance, across the region posterior to the vallate papillæ, the Blunk hæmostatic, crushing forceps is of considerable value.

The subtotal glossectomy is larger in its extent than the hemi-glossectomy, but is less difficult technically because the early division of the hyoglossus and genio-glossus muscles of both sides near the hyoid attachment, makes it possible to draw the root of the tongue far forward and facilitates the sectioning of the tongue in this region. As in the case of hemi-glossectomy, the preliminary cauterization of the surface of the cancer, the use of black thread suture guides, and the precaution against undue bleeding are important factors. In addition, it is important also to grasp the stump of the root of the tongue with traction sutures while the section of this region is being made, to prevent it from dropping back into the hypopharynx. To avoid confusing these sutures with the landmark guide threads, a different material, preferably linen thread, is used for the traction sutures.

In both hemi-glossectomy and the subtotal resection, it is desirable to have the mouth wound completely closed by suture. In the hemi-glossectomy, the remaining tongue segment is rolled over so that the former lateral border becomes the new dorsum, and the cut dorsal mucous membrane is sewed to the floor of the mouth. In the subtotal glossectomy, the mucous membrane of the floor of the mouth can be sutured to form a new floor over the gap in the midline. The suture material is fine silk (No. 1) or fine chromic gut (No. 0 or 00); and three knots are used instead of two, because of the tendency of these sutures to become untied in this moist area.

Fluid is given per rectum during 24 to 48 hours after operation, and then *via* the Einhorn tube with the Rehfuss tip, which may remain in place until the healing is sufficiently advanced to make swallowing safe. By means of a small catheter introduced through a nostril, the end of the Einhorn tube may be led out through the nostril, and its presence there causes a minimum of discomfort.

In dividing cancer operations upon the tongue and neck into stages, it was formerly the standard practice to dissect the neck lypmphatics, ligate the lingual artery and divide the tongue nerves in the first stage, and to operate upon the tongue ten to fourteen days later. This plan had its merit in furnishing the most favorable technical conditions in each operating field, first through the absence of marked inflammatory changes in the neck, and second, through the diminution in size and in vascularity of the tongue cancer, in the interval between the operations. Infection of the neck wound was less likely to occur if the mouth cavity remained unopened by operation. As a cancer procedure, however, this plan has been recognized as inadvisable and probably unsafe. The tongue cancer is the potential starting point of metastases, and in spite of the regressive changes following the ligation and the nerve section, it may continue to send metastases through the lymph channels into the neck wound; and other metastases may travel along unrecognized collateral lymph-vessel routes. This danger is increased if post-operative complications in the neck, or pneumonia, or the poor general condition necessitate the postponement of the second operation. From the cancer standpoint, therefore, the best plan of procedure involves the removal of the tongue segment with the primary cancer as part of the first stage, following up the regional metastases "centrifugally" in one or more stages.

The regional lymphatics of the tongue have been carefully studied and charted by Küttner (*loc. cit.*), Poirier ("The Lymphatics," Poirier, Cuneo, Delamere and Leaf), and Jamieson and Dobson (*Brit. Jour. Surg.,* 1922, vol. viii), who are in substantial agreement as to their distribution and extent; and their findings are borne out by the course of the metastases in clinical observations. To what extent and in what order the lymphatics should be removed in cases of cancer of the tongue, constitutes one of the important problems in cancer surgery. Some tongue cancers have been treated by excision of the tongue segment alone, and have remained well; but the unreported cases in this group that had recurrences in the neck are much more numerous. Metastatic cancer begins as a microscopic focus that cannot be palpated. In another group, a limited lymph-node removal has been done, and the microscopic examination of the nodes (done in the usual manner, without serial sections), showed hyperplasia alone; nevertheless, cancer recurrence appeared in the lymphatic region beyond the region excised. In any given case, it is obviously impossible to determine clinically (1) that there has been no lymph-node metastasis and (2) to what limits the metastasis, if present, has gone. It seems logical, therefore, to adopt the maximum as the standard procedure, and limit the scope of the excision in individual cases. In unilateral tongue cancers without demonstrable extension beyond the tongue, the submental nodes and the nodes of the "healthy" side of the neck are removed, from the mandible and the jugular fossa above to the level of the omo-hyoid crossing of the internal jugular below, including the broad lymphatic field posterior to the vein in the first operation. The tongue segment is removed at the conclusion of the neck operation. The conditions for the healing of the neck wound are thus very favorable, since

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leakage from the mouth cannot occur. The second operation may be postponed for two to four weeks, and it is advantageous to allow the patient to be out of the hospital for a week or ten days before the second operation is done, to improve his general condition. The second procedure involves the removal of all the lymphatics of the " diseased " side of the neck, from the mandible and the jugular fossa down to the clavicle. Experience has shown that it is not safe to operate upon both sides of the neck at one operation.

In cases in which the cancerous process is in the midline, involving both sides of the tongue, a similar extent and sequence may be followed, but it would seem safer to remove the whole lymphatic field on both sides. The supraclavicular region of the side included in the first operation may be left for a third step if necessary.

Variations in this sequence may be required for patients who are difficult to control and for those whose condition precludes extensive surgical interference, but the principle of removal of the primary tumor at the first operation and " centrifugal " progressive lymph-node removal seems essential.

When there has been demonstrable extension of the tongue cancer upon the floor of the mouth, or when there is demonstrable lymph-node cancer, new problems are presented by the necessity of splitting the jaw, removing the tumor and the nodes in one block, or removing node masses in different groupings—and the solution of these is individual for each given case.

Colonic ether anæsthesia and the prophylactic use of a hypodermoclysis of Ringer's solution with adrenalin during the operations have proven valuable aids.

THORACOTOMY IN BREAST CANCER

DOCTOR SEMKEN said that at the meeting of the New York Surgical Society held November 28, 1923, a case of resection of a segment of the chest wall for localized cancer was presented, that had remained well for two years and eight months following the operation (ANNALS OF SURGERY, 1924, vol. lxxix, p. 461). That patient is still free from recurrence, five years and seven months after operation. He now presented a similar case done in the same year, and also free from recurrence for over five years.

The woman, aged fifty-one years, came under observation May 9, 1921. Eleven years previously, a radical operation for cancer of the right breast had been performed at a hospital in New York City, and she had remained well until a few months previously, when a stony hard, pink, nodular mass appeared on the right chest wall in the region of the fourth rib at the scar from the earlier operation and posterior to it. It was a typical cancerous mass 4.5 x 2.0 cm., involving the skin and subcutaneous tissue, with fixation to the rib and the intercostal muscles. (Fig. 1.) No other metastases were demonstrable.

May 17, 1921, under colonic ether anæsthesia, the skin about the tumor was widely circumscribed, and the incision was extended upon the arm and down upon the midline of the epigastrium. The old scar was included in the removed tissue, thin skin flaps were reflected, the axilla and subscapular space were carefully cleared, the epigastric fat, upper anterior rectus sheath and the fascia over the serratus were removed, together with the fat and muscle tissue remaining upon the ribs and intercostal muscles, the dissection progressing from the periphery toward the tumor as a centre; and finally a segment

of the chest wall consisting of 8.0 cm. of the fourth rib with adjacent inter-
costal muscles, overlying tumor, and underlying pleura was removed—all in
a block dissection. The opening of the chest cavity caused no respiratory
embarrassment and only a partial collapse of the lung. It was covered at once

FIG. 1—Recurrent carcinoma of the chest wall, eleven years after radical operation for cancer of the
breast, case Mrs. M. S.

with a moist, warm towel and the wound was closed. The arm and upper
chest wound was sutured. The defect in the chest wall was covered with a
large sliding flap of skin and subcutaneous fat from the upper abdomen; and
the defect at this site was closed with a Thiersch graft. In the post-operative
course some uneasiness of mind was caused by necrosis at the tip of the flap,

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but this did not extend far enough to endanger the closure of the chest defect. No respiratory difficulty occurred at that time or since then; and the patient is apparently in excellent health, five years and five months following the operation. (Fig. 2.)

The microscopic examination of the removed tissue was reported by Dr. F. D. Bullock as follows: " The microscopical examination shows an epithelial growth which involves the skin and underlying tissues, the inter-

FIG. 2.—Sliding flap closure of the defect in the chest wall, late result, case Mrs. M. S.

costal muscles, and the rib. Tumor elements are observed in some of the medullary spaces of the rib; and the growth has reached the under surface of the rib by penetration of the intercostal muscles. The tumor cells are small and contain relatively large, round, hyperchromatic nuclei. They are polyhedral or irregular in shape and are arranged in narrow columns or strands, small groups or larger islands; or they form the lining of irregular spaces. No well-defined acini are noted, and mitotic figures are seldom observed. The stroma is abundant and is for the most part acellular and cicatricial, though in areas it is fairly cellular.

Diagnosis: Small-celled carcinoma of the thoracic wall with involvement of the rib."

PARALYTIC ILEUS AS A COMPLICATION OF ACUTE APPENDICITIS

DR. GUILFORD S. DUDLEY read a paper with the above title, for which see vol. lxxxiv, p. 729, December, 1926.

DR. CHARLES L. GIBSON stated that his experience with jejunostomy was very limited and that the few cases in his service at the New York Hospital which had been performed under conditions which Doctor Dudley had pointed out, had offered little prospect of usefulness having been done as a last resort; usually yielding to the urging of the family to exhaust every possibility.

Many cases have been seen with a marked peritonitis which might have been treated as the essayist has described; yet they recovered entirely without this measure.

The case for jejunostomy is still on trial and while it has its enthusiastic partisans there are a good many experienced surgeons to whom it does not appeal. The operation of jejunostomy itself, even if skilfully done, is a complication, and it is quite possible that some of the fatal cases might have succumbed as much to the effects of the jejunostomy as to the peritonitis. These patients do not die of an intestinal obstruction, that is, in cases of paralytic ileus without mechanical complications, they die of peritonitis, and if we can bring the peritonitis to an end most of these patients would recover.

Of recent years, our policy has been directed toward the arrest of the peristalsis and, rather than administering cathartics or intestinal stimulants such as pituitrin, giving the patients plenty of morphine, emptying the gastro-intestinal tract with frequent lavages and the introduction of fluid by the rectum, under the skin or even intravenously. Under these measures with confidence in them and patience it is remarkable how in many desperate cases the storm will blow over and eventually recovery will take place.

Much enthusiastic work has been done in regard to acute intestinal obstruction and most of it has been directed toward the search for a lethal factor in the intestinal contents. It is quite possible, even probable, that the source of trouble does not lurk in the intestinal lumen; but in the intestinal walls. By analogy we must remember what happens in the gall-bladder. Very often an acute inflammation of the gall-bladder will yield only a sterile culture of this condition; but active bacterial processes are found in the walls of the viscus.

DR. SEWARD ERDMAN said that in the series of over seventy cases of jejunostomy 42 per cent. had recovered. The majority of these patients had been operated upon on the Second Surgical Division of the New York Hospital. A study of this series had convinced Doctor Erdman that jejunostomy has a very definite value in the treatment of mechanical ileus, though he does not feel that it is of any great assistance in cases that show actively progressive general peritonitis. He believed that the ileus which is apparent during the first four or five days of an acute general peritonitis is to be considered

purely of the toxic or paralytic type, but that after the first five to seven days of a septic peritonitis the ileus is frequently due to adhesion of loops of bowel with kinking and obstruction.

The best results in the application of jejunostomy, therefore, have been obtained in those cases in which jejunostomy was performed later than the fifth day of the disease, although in many instances this time period may correspond with the time of the operation for appendicitis or follow it within one or two days. Doctor Erdman said that the average length of time for keeping the tube in the jejunum was from four to six days, and there was seldom indication for a longer period. He believed that the difficulty which some operators had with persistent duodenal fistula was due to making too large an opening or, more probably, to too long-continued drainage. In his own experience thirty-two patients had survived this operation, and in only two instances was a secondary procedure necessary to close the fistula; both of these were in children, aged eight and ten years, where the abdominal parietes were very thin, and also both were cases early in the series when the drainage had been unnecessarily prolonged. In all of the remaining thirty cases the fistula closed spontaneously with practically no leakage.

DR. ROBERT MORRIS disapproved of jejunostomies in cases of paralytic ileus after appendicitis operations. He believed that this form of paralytic ileus seldom occurred unless the appendicitis operation had been unnecessarily severe. This feeling was based upon the observation that ileus seldom occurred in olden times in the practice of physicians who refused to have appendicitis patients operated upon.

Furthermore, it was an extremely frequent complication at the height of the Third or Pathological Era of surgery when surgeons conscientiously felt that they must be very thorough in removing microbes and their by-products and inserting masses of gauze or other large drainage devices.

Surgery is now gradually merging into the principles of the Fourth or Physiological Era in which the natural resistance of the individual is conserved. As a corollary we now see much less of paralytic ileus following appendicitis operations than we did twenty years ago.

Handley's method and other jejunal operations are theoretically correct on the basis that virulent poisons really are found in the upper bowel in the presence of stasis. Practically, however, many vicious paraenteral organisms may be found in the free peritoneal cavity in these cases. Jejunostomy operations may perhaps intensify their activity.

So many ileus patients made good post-operative recovery after employment of the Murphy method or the Ochsner method, one or both combined, that the speaker would hesitate about introducing a serious surgical operation in a class of patients who at the time are not at all in condition to withstand the shock. Older and more conservative methods seemed to give much better statistics than are now being reported by surgeons who are trying out jejunostomy.

DR. ALEXIS V. MOSCHCOWITZ remarked that he could not fully share the enthusiasm of Doctor Dudley regarding jejunostomy. It is exceedingly difficult to evaluate the results of the operation because while the operation is usually done in very desperate cases, no one can tell whether or not the patient would have recovered even without jejunostomy. Some of the junior staff on his service find indications for this operation much more frequently than he does, therefore, he has sufficient experience with the operation and its results. Personally, Doctor Moschcowitz is of the opinion that patients who get well do so not because of jejunostomy, but in spite of it.

DR. FREDERIC W. BANCROFT said that all agreed that immediate post-operative rest of the gastro-intestinal tract is advisable to prevent the spread of peritonitis and the production of ileus. There was, however, one prophylactic method that he thought had not been given the attention it deserved. He referred to the Levin tube. These tubes are made in three sizes: for children, young adults, and adults. They are modified duodenal tubes. They are inserted through the nose into the stomach at the time of operation and are connected at the side of the bed to a bottle. The patient is then allowed to drink water which immediately returns to the stomach through the tube.

During the last six months, Doctor Bancroft and the Surgical Staff at the Lincoln Hospital had used this method, and feel that it cuts down post-operative vomiting entirely, and saves the patient from frequent lavages. He believes that lavages and vomiting are associated with spasmodic heaving of the diaphragm, therefore must tend to spread peritonitis and aid in the production of ileus. It is his opinion that the use of this tube may prevent the necessity for a jejunostomy.

DR. FRANK S. MATHEWS referred to recent statistics of the two surgical divisions at St. Luke's Hospital, on one of which enterostomies following appendicitis are moderately popular, and on the other division not employed. In the last year and nine months on the division employing ileostomy, the mortality has been $7\frac{1}{2}$ per cent., there being eight ileostomies with five deaths. On the division not employing it, the mortality has been 6 per cent. The only inference that could be suitably drawn from this series of over three hundred cases would be that the introduction of ileostomy has not corresponded with statistical improvement. Doctor Truesdell, of St. Luke's, last year reported his appendectomies in which there were no ileostomies, and his mortality was less than 5 per cent. The speaker had looked over thirty-nine recent consecutive acute appendix cases of his own in which there were two deaths. Neither of these were cases that could have been influenced by enterostomy. He did not wish to say that no case of acute appendicitis with ileus would be benefited by ileostomy, but with our present very low mortality in acute appendicitis, he thought that the cases in which it is indicated are very few, and it was his impression that in some hospitals it is being done much too frequently.

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BRIEF COMMUNICATIONS
RELIEF OF POST–OPERATIVE MASSIVE COLLAPSE
OF THE LUNG BY BRONCHOSCOPIC ASPIRATION*

TUCKER has recently reported two cases of post-operative massive collapse of the lung in which bronchoscopy with the aspiration of thick tenacious secretion caused immediate rel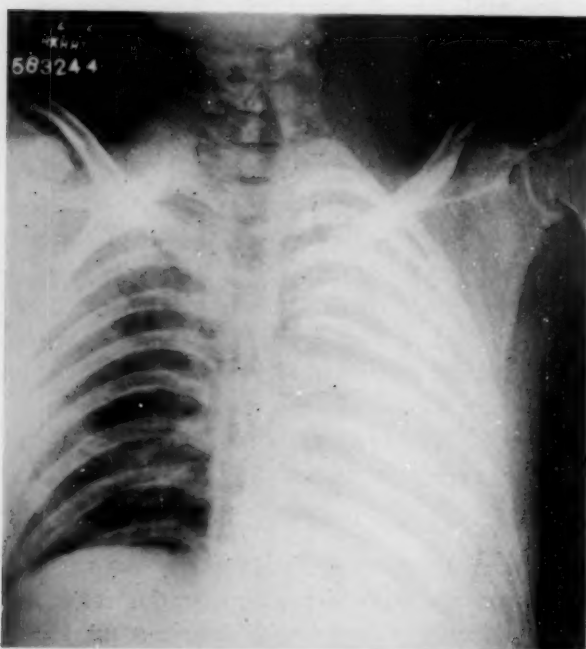ief from symptoms, and restoration of the displaced heart and mediastinum to normal position. He believes that the collapse of the lung was caused by bronchial blockage from thick secretion and absorption of air beyond the point of obstruction and accumulation of fluid, as is seen in certain cases of foreign body impacted in a bronchus.

FIG. 1.—Initial röntgenogram showing massive collapse of the left lung and marked displacement of the heart and mediastinum.

There may be other factors in the production of this so-called pulmonary collapse. One factor that has received scant consideration is the post-operative posture of the patient. Webb, Forster and Gilbert have shown that if a normal person is placed on the right side for an hour there is marked displacement of the heart and mediastinum to the right with atelectasis of the right lung. When there is normal postural deviation of the mediastinal structures, it is easy to understand how, immediately after operation, stagnation of the secretions on the compressed side with respiratory embarrassment may develop. The case presented here supports the latter hypothesis and shows the value of bronchoscopic aspiration of the retained bronchial secretion.

A man, aged twenty-eight, was operated on August 11, 1926, for removal of a large infected hydronephrotic right kidney. Ether anæsthesia was employed. The operation was long and difficult because of firm perinephritic adhesions. After the operation the patient was placed in bed on the left side. The following morning he noted a burning sensation beneath the sternum and in the afternoon a very severe pain in the left side
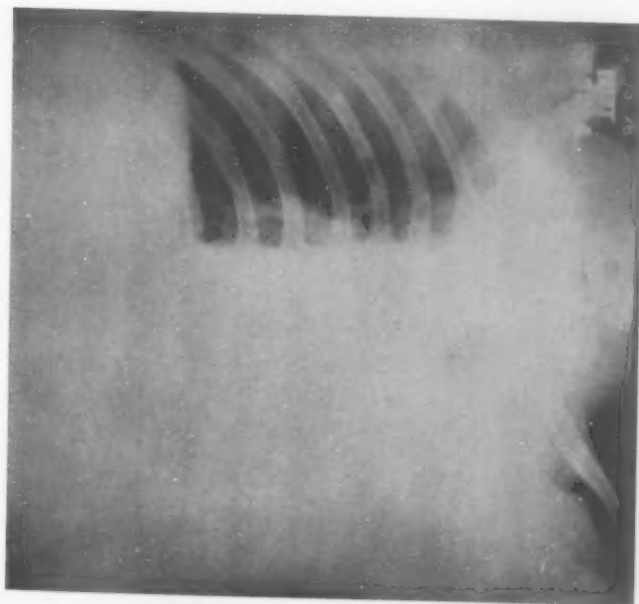
FIG. 2.—Twenty-four hours after first röntgenogram showing marked increase in density.
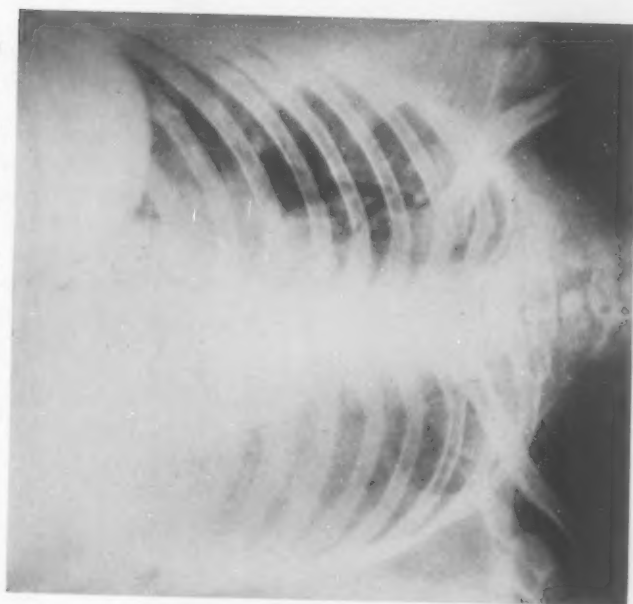

FIG. 3.—Examination of left lung showing marked clearing of left lung immediately after bronchoscopic aspiration, with restoration of heart and mediastinum to normal position.

of the chest. The temperature rose to 102°, the pulse rate to 110; respirations were 28. There was moderate cyanosis. The leukocytes numbered 7300.

Physical examination revealed displacement of the heart and mediastinal structures toward the left side, and marked diminution of breath sounds over the lower lobe of the left lung. Röntgen-ray examination revealed massive collapse of the left lung, and the heart and mediastinum pushed markedly toward the left (Fig. 1). The patient remained about the same for twenty-four hours, when dyspnœa and cyanosis became marked and the respi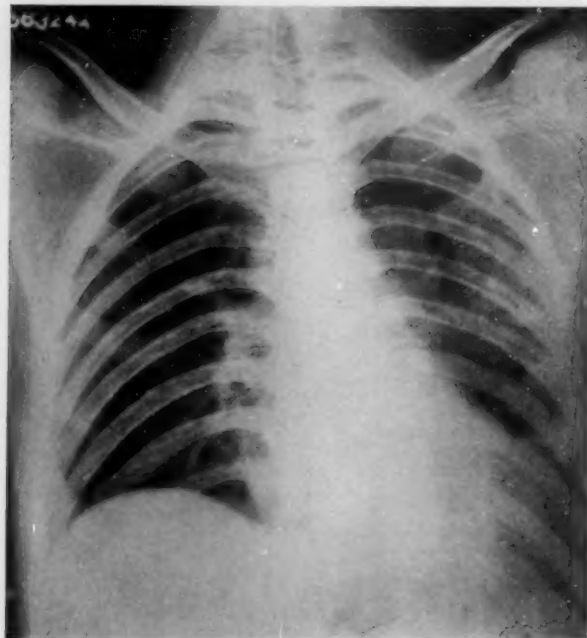rations were 48. Death seemed inevitable. The leukocytes had dropped to 4400. Röntgen-ray examination showed an increase in density over the left side of the chest (Fig. 2). Bronchoscopy was then performed under local anæsthesia, and on the introduction of the tube a thin serous secretion poured out of the trachea. About 300 c.c. of fluid was aspirated from the left lung. There was severe tracheobronchitis. Although all of the secretion seemed to come from the left lung, the consistency was not thick, as in cases observed by Tucker. The dyspnœa and cyanosis subsided immediately after aspiration of the fluid; a röntgenogram made fifteen minutes afterward showed the heart in normal position and marked decrease in the pulmonary density (Fig. 3).

FIG. 4.—Condition of patient at dismissal.

Recovery from this time on was entirely uneventful, and the patient was able to leave the hospital on the sixteenth day. At the time of dismissal the röntgenograms of the chest revealed nothing abnormal (Fig. 4).

DRS. JAY R. COFFEY and PORTER P. VINSON were associated with the reporter in the care of this patient.

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TERATOMA TESTIS WITH METASTASIS

A man, aged thirty, was admitted to the National Military Hospital at Sawtelle, Cal., January 5, 1926, complaining of pain in the back and across the upper part of the abdomen. There was a large mass in the abdomen; also a lump in the scrotum.

He dated his present illness back to August, 1925, at which time he was forced to quit work. In September, 1925, at the Tacoma General Hospital, he stated that a tumor mass was found in his abdomen.

On admission at the Sawtelle Hospital the pains across the lower part of his back were practically continuous, sharp at times, at others dull and aching in character. They radiated from one side of the back to the other. Occasional similar pains across the upper abdomen were severe only after the manipulation of an examination. There had been some nausea but no vomiting. He had to take a cathartic every other day.

In January, 1924, there had been swelling, redness and soreness in the left testicle. There were no chills, but he thought he had some fever and he " felt badly all over." The swelling subsided every evening when he got off his feet. He could recall no trauma. Ten days later the condition had entirely cleared up. Three months later he noticed, for the first time, " a small, hard knot about the size of a large pea in the left testicle." It was not tender. The mass gradually increased in size until, at the time of admission here, it measured six by four centimetres. It had never been painful.

His weight and strength had held up well until August, 1925; since then there had been a gradual loss in both until he could scarcely walk across the room because of weakness and the pains in the back. He was poorly nourished, weighing 122 pounds (normal weight 158 pounds). The knees drawn up because this position relieves the pain in his back, especially of the left side. Moderate exophthalmos. The pupils round and equal, but react sluggishly to light. No pathology in the fundi.

There is moderate dilatation of the superficial veins of the chest. The superficial veins of the abdomen moderately dilated, more on the left. A large, firm, fixed, irregular, tender mass in the upper right quadrant, palpation of which makes the patient, " sick all over." The left testicle is hard, irregular, not translucent and not abnormally tender, and freely movable in the scrotum. Kernig 160 degrees right and left. Deep reflexes equal and hyperactive; the abdominalis absent. Slight tenderness in the lumbar and sacral regions; and bending backward causes pain.

Temperature subnormal, pulse 100, regular in force and rhythm. A trace of albumin in his urine. The blood findings: Hæmoglobin (Dare) 57 per cent., erythrocytes 4,024,000, leukocytes 9000, polymorphonuclear neutrophiles 75 per cent., lymphocytes 18 per cent., transitionals 6 per cent., myelocytes 1 per cent., Wassermann negative.

X-ray Findings.—The dorsal, lumbar and sacral spine show no positive evidence of injury or disease. Chest, both bases show marked annular, well circumscribed discrete shadows extending as high as the second interspaces. The lungs above and surrounding these areas show fairly good aeration. The apices are clear. Evidence of secondary metastasis. Gastro-intestinal tract, . . . in conclusion, malignancy of the antrum, first portion of the duodenum, . . . indirect evidence of malignancy of the liver.

He died January 26, 1926.

Autopsy.—Pleuræ adherent to chest wall most marked at the bases. Lungs interspersed with many grayish-white tumor masses well defined and regular in outline, varying in size from one and one-half to five cm. in diameter, more numerous at the bases. One of the larger ones showed necrosis. The liver a third larger than normal. Scattered through its substance numerous sharply defined regular grayish-white tumor masses ranging in diameter from one to four cm. The larger of these tumor masses showed necrotic changes.

The recto-peritoneal glands formed an irregular tumor mass extending along the left iliac vein from Poupart's ligament well up into the upper left quadrant, and across the midline in practically its whole extent. Two-thirds of the mass necrotic.

The left testicle measures five by three and a half cm. On section the lower pole made up of a rounded mass two and a half by two and a half cm. containing yellow caseous material.

The microscopical findings by Dr. Frank Sturdivant, Pathologist of the Pasadena General Hospital: " Sections from the testicle: The primary tumor in the testicle shows areas resembling typical carcinoma of the ducts, epithelium of the squamous type in islands, small areas made up of cartilage cells, and larger areas of degeneration. Sections from the liver show a metastatic tumor. It is entirely epithelial in character. Sections from the lung: The character of the cells in the metastatic tumors of the lung are, also, epithelial in character. Diagnosis: Teratoma testis, embryonal in type, with metastasis to the liver and lung. This is the usual site of metastasis of this tumor."

Sections sent to Dr. Frank Hinman * brought this reply: Sections of the testicular tumor show a confusion of structures, all more or less embryonal in character, representing all three germ layers. Most of the stroma is composed of rather embryonal connective-tissue cells. Occasional cells are seen that suggest nerve fibres. Smooth muscle cells are present in small numbers. Masses of cartilage, varying in structure from embryonal to adult types, are rather numerous. Ectoderm is represented by islands of squamous epithelium and by small cysts lined by squamous cells. Some of these islands show marked cornification. Many glandular structures of entodermal origin are present. Some of these have undergone malignant changes and carcinomatous areas are present everywhere throughout the sections. These carcinoma cells show relatively little variation in size and shape. Only an occasional mitotic figure is seen. Large areas of degeneration and necrosis are present throughout the tumor.

Sections of the liver show metastases. These metastases are entirely carcinomatous in character. Masses and strands of epithelial cells with some tendency toward alveolar and papillary arrangement are seen. The nuclei of these cells vary considerably in size and shape. Mitotic figures are fairly numerous. There is relatively little connective-tissue stroma.

Sections of the lung show similar metastases. There is, however, less tendency towards pattern formation and most of the cells are arranged in groups and diffuse sheet-like masses.

Diagnosis.—Teratoma testis, embryonal type, with carcinomatous areas of entodermal origin and carcinomatous metastases in the liver and lung.

From the service of John William Shuman, M.D., Hospital, National Soldiers' Home, Sawtelle, Cal.

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EXTRAPERITONEAL HERNIA OF THE BLADDER

THIS case is presented because of its diagnostic difficulties, increased surgical risk and unusual findings at operation.

E. L., colored male, Case No. 125,272, Wesley Memorial Hospital, was referred by the cardiac dispensary to the hospital on May 25, 1926, because of a painful mass in the right inguinal region.

This mass had been present for about thirty years but had not caused any trouble until several months ago, when the patient was seized with severe pain in the lower abdomen. This pain was located over the bladder and over the area of the mass. The pain was so severe that he was sent to the Cook County Hospital. In six days he got better and went home. The pain returned three days before admission and he was referred from the dispensary because of his cardiorenal condition to the local anæsthetic clinic.

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EXTRAPERITONEAL HERNIA OF THE BLADDER

On admission a large well-developed, well-nourished, colored male was found. In the right inguinal region a soft, resilient, nearly fluctuating mass was found of the size of a goose egg. It was not reducible in size, could not be pushed back into the abdominal cavity, although it seemed to pass into the inguinal canal at the external ring. The palpating finger could not enter the external ring. It did not increase on coughing and pressing. The cord lay on the posterior lateral surface of the tumor. The mass could be separated from the testis.

On the day after admission, Doctor de Takats, with local anæsthesia, exposed the tumor by suitable incision. A resilient fluctuating mass was found here covered by the transverse fascia. The mass was distinctly separated from the cord, which lay posterior and laterally to it. On splitting the transverse fascia a fatty tumor of the size of a fist appeared which was isolated down to the external ring. The pedicle of this mass lay mesially to the epigastric vessels. On dissecting through the fat with two anatomical forceps, a thick muscular layer was found, which was identified as the bladder wall. The wall was hypertrophied and painful on pressure, because sacral nerves were not blocked. The opening through which the bladder prolapsed permitted only one finger-tip to enter. Several attempts to reduce the bladder through this opening were in vain because of the small opening. Therefore a laparotomy was made, starting from the external ring upward. It was now seen, that the prolapsed bladder wall is below the peritoneal reflection. Bladder could now be pushed back in place. There was no evidence of injury to the wall. The lateral vesical ligament was well visible. Peritoneum was closed. A transposition of the cord was made according to Bassini with duplication of the external oblique aponeurosis above the cord. Skin was closed with clips. Uncomplicated recovery.

Discussion.—Hernias of the bladder are not rare. Brunner found one in every hundred hernias. They may be inguinal, crural, perineal, obturatory, sciatic or even in the linea alba. Most frequently, however, they are direct inguinal hernias, like our case. As to their relationship to the peritoneum, they are intraperitoneal, paraperitoneal or sliding and extraperitoneal. The sliding type is the most frequent. From the analysis of the reported cases it is apparent that most of these sliding hernias are artificial and are produced by the traction on the hernial sack during operation. The extraperitoneal type, to which our case belongs, is very rare. Of a series of 180 cases of bladder hernia, only six of this type were found.

Predisposing factors to bladder hernia can be:

(1) *Bladder distention* due to prostatic enlargement, urethral strictures, bladder stone and diverticulum. In our case a polyuria and a pollakisuria were present. A connection between these symptoms and the prolaps of the bladder is hard to establish. The mass, according to the patient's history had been there for thirty years.

(2) *Prevesical lipomata* have been reported in all cases of bladder hernia. Their rôle just as that of preperitoneal lipomata in hernia formation has often been emphasized and as a predisposing factor generally accepted.

(3) *A weak inguinal canal,* which factor involves the whole question of hernia disposition. It seems clear, that an overdistended bladder with prevesical lipoma pulling it forward could never pass a normal external inguinal ring.

(4) *Previous injections* at the site of the hernia resulting in scar tissue formation may cause an adherence of the bladder to the inguinal ring (Finsterer's case).

The diagnosis is usually only made at operation and sometimes only when the bladder wall has already been perforated. However, the pre-operative diagnosis is possible if one only thinks of it. Following are the main diagnostic points: a resilient, fluctuating mass, separable from cord and testis, irreducible, painful on pressure, is always suggestive of bladder hernia. If the mass gets smaller after urination, or if a metal catheter can be introduced into the mass through the bladder, the diagnosis is made. These symptoms were not present in our case. The colics are felt over the mass and irradiate to the region of the bladder. A cystoscopic examination will easily reveal the condition.

In our case the colicky pain, which meant bladder incarceration, irradiated over the whole bladder. This symptom has been noted by one of the staff (Doctor Mason). This symptom, together with the other findings, should have aroused at least the suspicion of bladder hernia, which could then have been confirmed by cystoscopy. The diagnosis during the operation is made by the appearance of prevesical fat, below which the typical muscle layer appears. In our case the first attention was drawn to the bladder by the pressure pain, which is unusual in the hernia. Had the diagnosis been made before the operation, a block of the sacral nerves would have easily anæsthetized this part of the operation. As it was, it gave a diagnostic lead.

The incarceration of the bladder into the external ring was only partial. The constricting tissues do not seem strong enough to cause a gangrene. In our case, during cystoscopy an œdema of the involved region, with a small submucous hemorrhage was seen. It is impossible to decide whether this was due to the incarceration or the surgical trauma.

Sometimes even the ureteral opening or one of the ureters may be in the prolapse. This may cause a kink and a hydronephrosis. In other instances a diverticulum was found or a stone had formed in the prolapsed part of the bladder. There cannot be a very free communication between the two separated parts of the bladder, as pressure on the mass, like in our case, seldom reduces the size of the prolaps.

Collective statistics with analysis of cases may be found at Imbert (1896), Brunner (1898 and 1909), and more recently Finsterer (1912).

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SURGERY OF COMMON DUCT OBSTRUCTION

Cholecystectomy is the logical treatment for chronic cholecystitis, with or without stones. The gall-bladder is the birthplace for the large majority of gall-stones, and when infected carries the infection in its walls, so that its removal destroys the infection as well as reducing the chances for recurring stones to a minimum. Removal of the gall-bladder in uncomplicated biliary disease is fraught with very little danger to life, less than two per cent., and from a practical viewpoint causes no inconvenience to the patient.

Common bile duct obstructions are due to stones, post-biliary operations, malignancies, pancreatitis and peptic ulcers, in the order named. Stones by far predominate. It is logical to assume, therefore, that early removal of the gall-bladder in biliary disease will act in a large part in the prevention of duct obstruction.

Stone formation in the hepatic ducts is the exception, and whether or not stones can form in the biliary ducts is at present unknown. As far as is known, stone formation is dependent upon gall-bladder infection and an increase in the cholesterol content of the blood.

While surgery, of course, is the only method of dealing with common duct obstruction, surgery still carries an almost prohibitive mortality. G. P. Malley in a series of acute cholecystitis with common duct obstruction cites a mortality of forty per cent. In chronic cholecystitis with common duct obstruction his mortality was 19.2 per cent. It may be safely said that in all hands, the mortality of common duct obstruction to-day varies between fifteen and fifty per cent. Although transfusions, calcium chloride, glucose, reservation of heat, etc., may have reduced the mortality somewhat, still it is far too high for comfort.

The causes of the high mortality may be classified as follows: (a) Impaired liver function (back pressure) (toxæmia); (b) hemorrhage; (c) general peritonitis; (d) complications which may follow any surgical procedures. The last may carry a mortality of one per cent. or less. Therefore the first three carry by far the heaviest mortality.

If these three are the main causes of death therefore, it follows that if they can be eliminated, the mortality will be greatly reduced.

We have attempted to accomplish this in our recent work and now have a series of fifteen obstruction cases with one death, whereas formerly our mortality was very high. The death which occurred was in a case which necessitated a duodenostomy and died from general peritonitis.

The routine is as follows: First stage: Cholecystostomy. Second stage: Removal of duct obstruction. Third stage: Cholecystectomy. The first stage consists of exploration and drainage of the gall-bladder, care being taken to remove all stones in gall-bladder and cystic duct so that drainage will not be impaired. The tube for drainage is anchored to the gall-bladder with linen or silk and the wall is carefully invested about the tube to prevent leakage so as to reduce adhesions to a minimum.

The patient is then allowed to rest for several weeks or months if neces-

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sary until jaundice has entirely disappeared and until blood-clotting, settling and viscosity are normal. Checking may also be made with the Vonden Bergh test—a very satisfactory test in this type of case.

When all these tests are normal the second operation is performed, removing the obstruction if possible, and always opening and draining the common duct, even in case of duodenostomy. The gall-bladder and its drainage tube from the first operation are not disturbed.

The tube in the common duct is removed in seven days and the tube in the gall-bladder removed several days later.

Whether or not to perform cholecystectomy, the third operation, is dependent upon the condition of the gall-bladder, found upon exploration. In my opinion it is advisable in all such cases to remove the gall-bladder, to prevent possible recurrences.

The above procedures, at first sight, might suggest difficulty in re-operating upon operated ground, but such has not been our experience. The few adhesions found at the second and third operation are readily dispersed to make way for the later procedures.

The procedures are not unlike preliminary cystotomy in advanced prostatic removal (two-stage operations). The advantages are as follows:

First: By preliminary drainage, back pressure on the liver, with return to normal function, is overcome. This in our opinion as the most frequent cause of death in these cases (toxæmia from low liver function).

Second: The danger of hemorrhage is absent by the removal of the bile pigments from the blood (removal of jaundice).

Third: Peritonitis is less apt to occur because of the walling-off process which follows the first operations—because of increased protective agencies of blood and peritoneum due to the removal of toxic substances from the blood—a certain amount of immunity produced (non-specific) following the first procedure.

Although our number of cases have been rather limited (fifteen), still it seems to me in following these cases that a condition which has hitherto carried a high mortality rate may be reduced in severity to one conforming with other surgical procedures, and should carry a mortality not to exceed two per cent.

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